DEXTER WILSON ENGINEERING, INC.

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MASTER RECLAMATION PLAN
FOR THE MONTECITO RANCH
SEWER MAINTENANCE DISTRICT
IN THE COUNTY OF SAN DIEGO

January 7, 2010

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CHAPTER 1

INTRODUCTION

This report provides a Master Reclamation Plan for the proposed Montecito Ranch Sewer Maintenance District. The proposed Sewer Maintenance District will provide sewer service for the proposed Montecito Ranch project, a master-planned community located in an unincorporated area of northeastern San Diego County just north of the town center of Ramona. Currently, the project area is undeveloped.

PROJECT OVERVIEW

The Montecito Ranch project is located in the County of San Diego north of the town of Ramona. State Highway 78 is located to the north and east of the property. The project's southern boundary is located to adjacent development on the outskirts of Ramona. Figure 1-1 presents a location map of the project.

DEVELOPMENT PLAN

The Montecito Ranch project development is planned as a residential community of approximately 417 single family dwelling units on a total land area of 935.3 acres. In addition to single family residential land use, the project proposes a historical park site a community park site, a wastewater reclamation facility, and open space. Residential development will include only single family detached units.

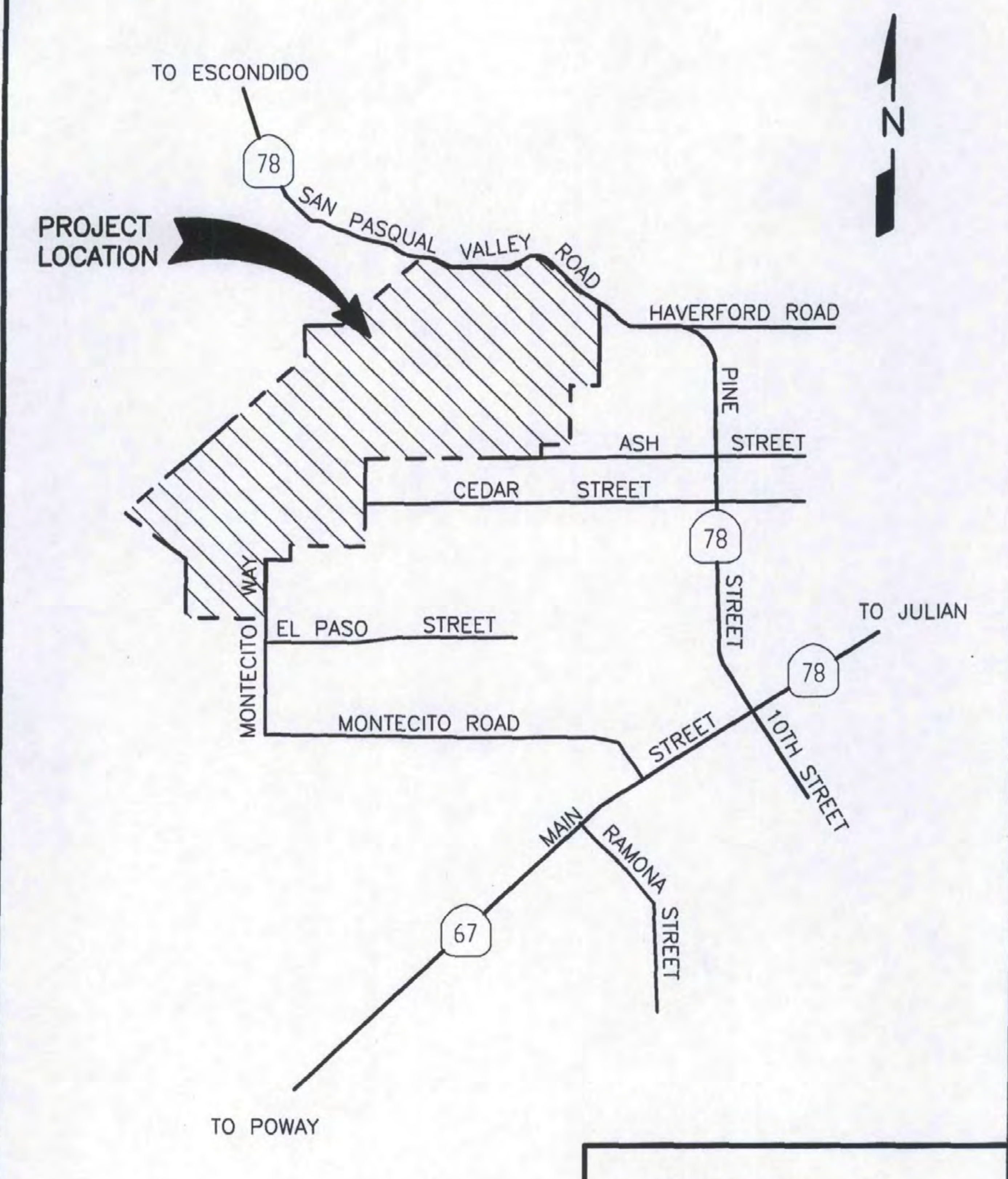

FIGURE 1–1

MONTECITO RANCH
LOCATION MAP

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TOPOGRAPHY

The existing topography on the property ranges in elevation from a low of approximately 1,270 feet to a high of approximately 1,760 feet. The topography varies over the project site but generally the site is split into two drainage areas. The high point of the project is near the middle of the property with the western portion draining to the northwest and southwest. The eastern portion of the property drains primarily to the north and northeast. The higher elevations of the property are not planned to be developed because of the steepness of the existing terrain.

The proposed development of the Montecito Ranch project is limited to a range of elevations from a low of 1,460 feet to a high of approximately 1,630 feet.

PURPOSE OF STUDY

The purpose of this study is to establish a sewer drainage basin and describe the sewer facilities required to convey, treat, store, and dispose of sewage generated within the proposed Montecito Ranch Sewer Maintenance District.

Additional planning and operational studies as well as design plans and specifications will be required for all facilities to implement this Master Reclamation Plan. These additional items will be prepared concurrently with the project's final engineering improvement plans.

SEWER SERVICE

The Montecito Ranch project is proposing to obtain sewer service by forming a sewer maintenance district which will be administered by the County of San Diego. This maintenance district will own and operate the wastewater collection, treatment, and disposal facilities to be constructed to serve the Montecito Ranch project. Funding of the sewer maintenance district will be from user fees paid by the property owners within the Montecito Ranch development project.

Formation of any new sewer maintenance district must be approved by the County Board of Supervisors. Should the Board of Supervisors approve formation of a sewer maintenance district or other dependent County special district to provide sewer service to the project, financial and operational agreements for the proposed sewer collection, treatment, and disposal facilities will be required and made conditions of the Montecito Ranch project approval.

Regulatory Considerations

The project will need to obtain a Waste Discharge Permit from the San Diego Regional Water Quality Control Board. All of the sewage generated by the project will be treated and recycled on-site.

The project will also have to comply with State and County Health Department requirements for the use of recycled water, including Title 22 requirements for unrestricted reuse. The emergency generators for the pump stations and water reclamation facility will need to be permitted by the San Diego Air Pollution Control District.

CHAPTER 2

WASTEWATER SYSTEM DESIGN CRITERIA

This chapter presents the planning and design criteria used in estimating the flow and strength of the wastewater generated by the proposed Montecito Ranch residential development project. The criteria utilized in this report are established in accordance with the County of San Diego Uniform Sewer Ordinance as modified by Ordinance No. 9103.

PIPELINE DESIGN CRITERIA

Gravity sewer lines 15-inches in diameter and smaller will be designed to convey peak dry weather flows while not flowing at more that 50 percent full by depth. Gravity sewer lines will be designed to flow at a minimum velocity of 2.0 feet per second during peak flow conditions or have a minimum slope of 1.0 percent to prevent the deposition of solids. Manning's equation with an "n" value of 0.013 was used in the analysis to determine the pipeline flow conditions. Sewage force mains will be designed for a flow velocity of 2.5 fps minimum and 5 fps maximum.

WASTEWATER FLOW GENERATION FACTORS

Wastewater flow generation factors were taken from the County of San Diego Uniform Sewer Ordinance (Ordinance No. 9103). A copy of this ordinance has been included in Appendix A for reference. The factors are shown in Table 2-1.

To convert average daily flow rate to peak dry weather flows, the population based peaking factor chart from the City of San Diego Metropolitan Wastewater Department was utilized. This peaking factor chart has been included in Appendix B.

PROJECTED SEWAGE FLOWS

Table 2-1 provides the projected wastewater flows for the Montecito Ranch project. The total projected average sewage flow is 0.11 mgd.

TABLE 2-1 MONTECITO RANCH PROJECT SEWER FLOW PROJECTIONS			
Land Use	**Quantity**	**Sewer Generation Factor**	**Average Wastewater Flow, gpd**
Single Family Residential	417 units	240 gpd/unit	100,080
Wastewater Treatment Facility	1 EDU	240 gpd/EDU	240
Historical Park Site	5 EDUs	240 gpd/EDU	1,200
Parks (8.3 ac developed)	8.3 acres	500 gpd/acre	4,150
TOTAL			**105,670**

Peak Dry Weather Flow

Peak sewage flow to be generated by the Montecito Ranch development project is calculated using the City of San Diego Metropolitan Wastewater Department peaking factor chart included in Appendix B. The chart is based on population. The estimated population was obtained by dividing the total projected average sewage flow by 240 gpd/EDU and multiplying by 3.5 people/EDU. The resulting population equivalent is 1,541 people which results in a peaking factor of 2.37. Thus peak dry weather flow for the Montecito Ranch project is 250,438 gpd.

Peak Wet Weather Flow/Pump Station Flows

For the design of all sewer pump stations, a peaking factor of 1.3 will be applied to peak dry weather flow. This will provide a 30 percent safety factor for sewer pump station pumping capacities to account for peak wet weather flows

DESIGN WASTEWATER STRENGTH LOADINGS

We are assuming 3.5 persons per dwelling unit for a total population estimate of 1,541 people for the Montecito Ranch project. Average daily wastewater strength loadings are based on the typical value with garbage disposals per Table 3-12 of Metcalf and Eddy, 4th Edition. Table 2-2 below provides a summary of the wastewater loadings.

TABLE 2-2 DESIGN STRENGTH LOADINGS			
Constituent	Loading per Person[1] lbs/day	Average Loading	
		lbs/day	mg/l
BOD_5	0.22	339	385
COD	0.48	740	840
TSS	0.25	385	436
NH_3 as N	0.019	29	33
Organic N as N	0.013	20	23
TKN as N	0.032	49	56
Organic P as P	0.0028	4.3	4.9
Inorganic P as P	0.0048	7.4	8.4
Total P as P	0.0076	11.7	13.3

[1]Wastewater loading factors from Table 3-12, Metcalf & Eddy, 4th Edition

CHAPTER 3

PROJECT LAYOUT

Figure 3-1 shows the proposed development plan for the Montecito Ranch project. Superimposed on the graphic is the configuration of the sewer collection system and the location of the wastewater reclamation plant site for the proposed Montecito Ranch Sewer Maintenance District. This figure also identifies the locations of the two sewer pump stations, the wet weather storage ponds, and the spray disposal fields.

The wastewater reclamation plant and wet weather storage ponds are located on the southwest side of the project. The elevation of the treatment plant site is 1,442 feet. Flow directly upstream of the reclamation plant site is by gravity; this gravity sewer is fed by two force mains from two separate sewer pump stations. All the residential development flows through one of the two onsite sewer lift stations. The parks along Montecito Ranch Road flow by gravity to the reclamation plant site and therefore do not contribute flow to either of the sewer lift stations.

SEWAGE CONVEYANCE SYSTEM

Figure 3-1 also shows the location and sizes of the sewage conveyance system. The majority of the system is 8" diameter. The exceptions are the two 4" force mains from the east and west onsite sewer lift stations.

SEWER PUMP STATIONS

There are two onsite sewer pump stations that will be needed to serve the Montecito Ranch project. All of the sewage generated by the residential land uses in the project will be pumped by these stations to a gravity sewer in Montecito Ranch Road.

The easterly lift station is at elevation 1,520 feet and pumps up to a high point in Montecito Road of 1,620 feet. Thus the static head for this lift station is 100 feet. The western lift station will have a static head of about 113 feet pumping from a lift station elevation of 1,505 to a discharge elevation in Montecito Road of 1,618 feet.

A third sewer lift station will be located at the wastewater reclamation facility. This lift station will function as the influent pump station at the wastewater reclamation plant to lift sewage from the gravity sewer to the treatment plant headworks.

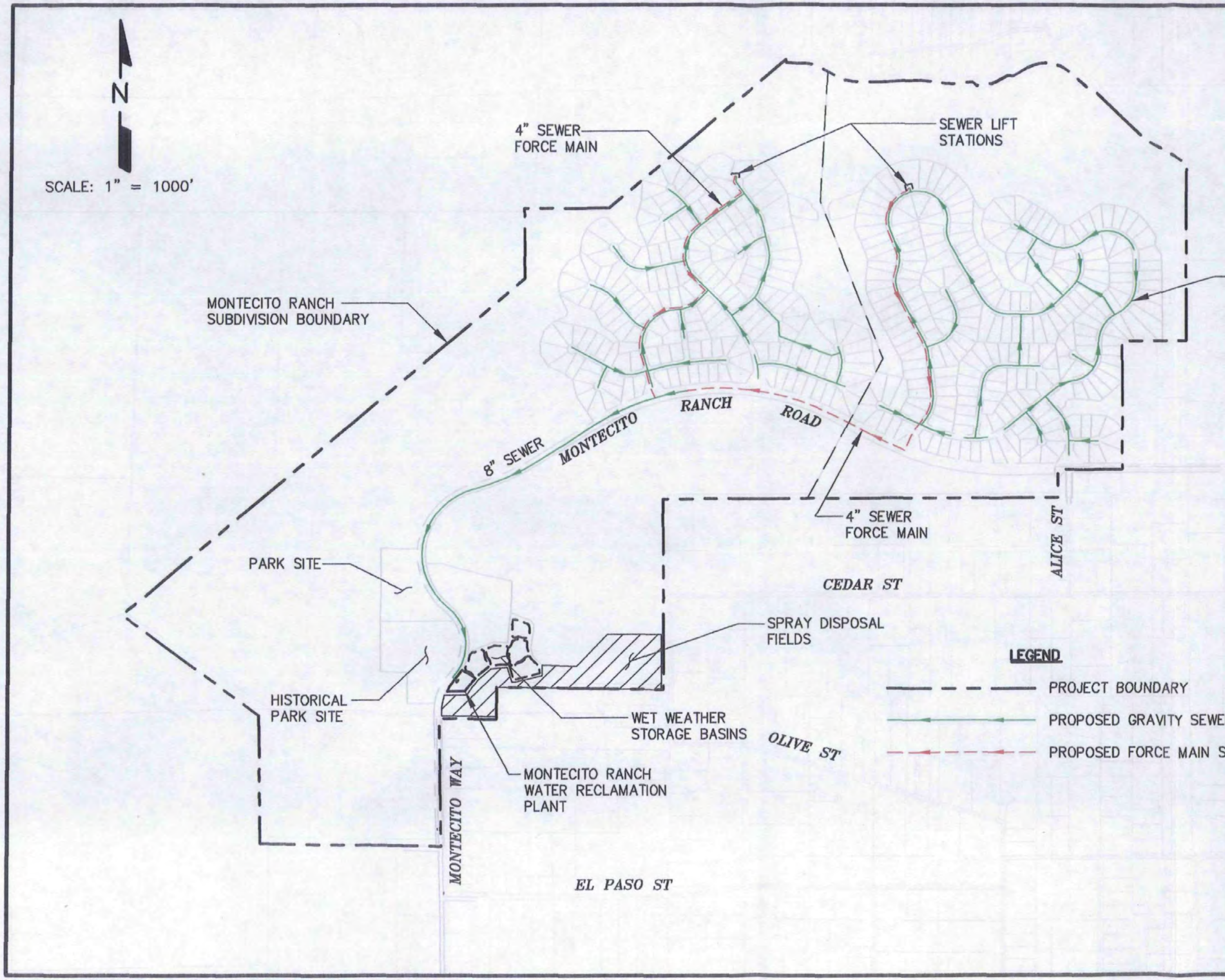

FIGURE 3-1
MONTECITO RANCH SEWER COLLECTION SYSTEM

\\PACIFIC\DWG\669008\MASTER RECLAMATION PLAN\FIGURE_3-1.DWG 11-04-09 13:18:01 LAYOUT: FIGURE

Pump Station Descriptions

Each proposed sewer pump station will include two pumps; each pump will be sized for the peak sewer flow to each station. As presented in Chapter 2, the pump station pumping capacity will be calculated as 1.3 times the peak dry weather sewer flow.

The eastern sewer lift station will receive flow from 247 dwelling units. Thus, the pumping capacity is estimated to be:

247 EDUs x 3.5 persons per EDU = 864 persons
From Appendix B, the peaking factor is 2.75
Then: 247 EDUs x 240 gpd/EDU x 2.75 PF x 1.3 PF / 1,440 = 150 gpm
Force main velocity: 4" force main, 3.8 fps

The western sewer lift station will receive flow from 170 dwelling units. Thus, the pumping capacity is estimated to be:

170 EDUs x 3.5 persons per EDU = 595 persons
From Appendix B, the peaking factor is 3.0
Then: 170 EDUs x 240 gpd/EDU x 3.0PF x 1.3 PF / 1,440 = 110 gpm
Force main velocity: 4" force main, 2.8 fps

The parks along Montecito Ranch Road flow by gravity to the water reclamation plant.

Both of these sewer pump stations within the residential portion of the Montecito Ranch subdivision will have emergency power generation.

The lift station at the influent to the wastewater reclamation plant will also contain two pumps and have provision for standby power. The capacity of each of the two pumps will be the peak flow generated by the Montecito Ranch project which was estimated to be:

440 EDUs x 240 gpd/EDU x 2.37 PF x 1.3 PF / 1,440 = 226 gpm

Since the wastewater reclamation plant cannot be started up until there are 50 units on line, the wet well at the influent sewer lift station will be utilized to provide a forebay for storage of sewage generated from the first units occupied onsite. This sewage will be hauled by pumper truck to another treatment plant for treatment and disposal. The Montecito Ranch developer will be responsible for operation and maintenance of the pump stations and wastewater reclamation plant until full acceptance of the facilities by the County.

CHAPTER 4

DESCRIPTION OF WASTEWATER RECLAMATION PLANT

The process flow schematic for the proposed Montecito Ranch Wastewater Reclamation Plant is shown in Figure 4-1 and the layout of the plant site is shown in Figure 4-2. All treatment processes will be located in concrete tanks. The plant will be designed to meet the reliability requirements in accordance with Title 22 of the California Code of Regulations. The plant will be designed to produce disinfected tertiary recycled water meeting the requirements of Section 60304(a) of Title 22 of the California Code of Regulations. The information presented in this chapter is a conceptual plan prepared for site sizing. The entire process selection for the wastewater reclamation plant, all its components, and its equipment shall be subject to review and approval by the County of San Diego.

INFLUENT SCREENING

Influent screening will be utilized prior to the secondary treatment process. The screening process will have back-up provisions. An influent flow meter will be provided.

SECONDARY AND TERTIARY PROCESS

The plant will utilize an extended aeration biological secondary process with clarifiers to separate the sludge from the treated liquid stream. The clarified effluent will then be treated to a tertiary level using either filters or a membrane process.

DISINFECTION

Disinfection at the plant will be accomplished through the use of sodium hypochlorite and a chlorine contact tank or ultraviolet radiation. The system will be designed to meet the requirements of the California Department of Health Services. Department of Health Services certification will be required prior to delivery of treated effluent from the plant for reuse.

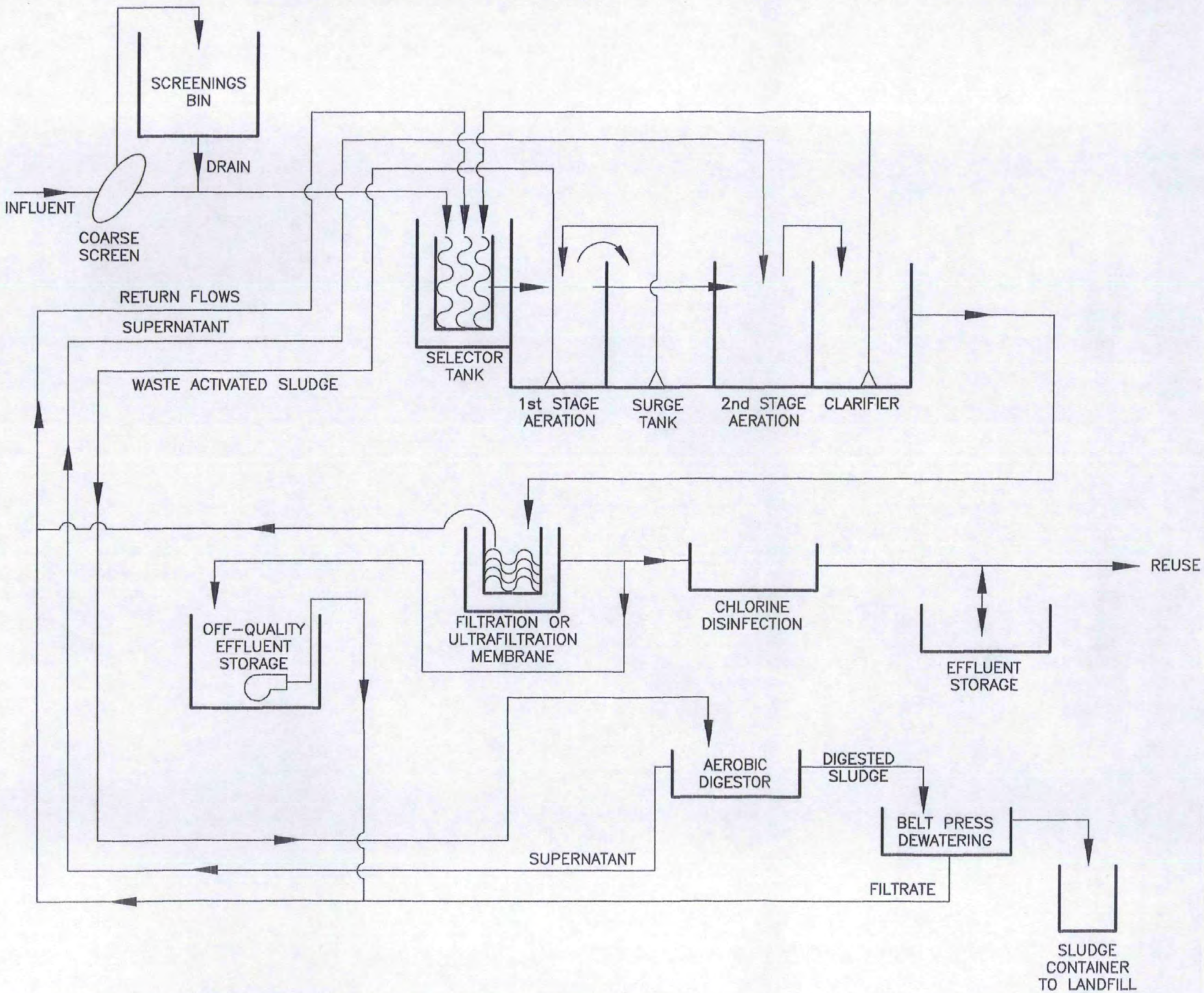

FIGURE 4-1

PROCESS FLOW SCHEMATIC

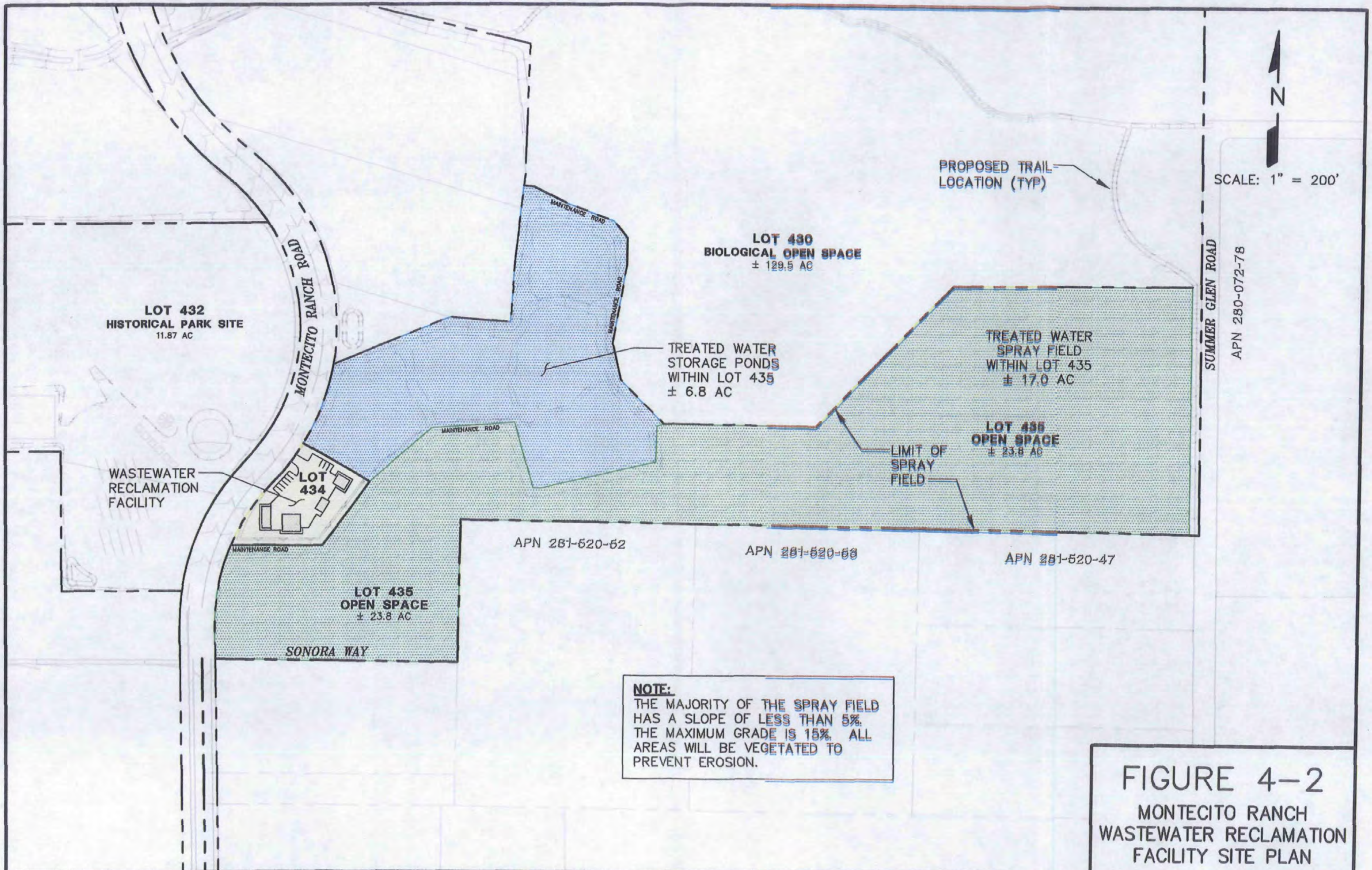

FIGURE 4-2

MONTECITO RANCH WASTEWATER RECLAMATION FACILITY SITE PLAN

\\PACIFIC\DWG\669008\MASTER RECLAMATION PLAN\FIGURE_4-2.DWG 01-06-10 15:26:43 LAYOUT: FIGURE

EMERGENCY GENERATOR

A diesel engine driven emergency power generator sized to operate the entire plant will be provided at the reclamation plant. Fuel storage will be provided with sufficient capacity to operate the generator at maximum load for 24 hours.

PLANT DRAIN SYSTEM

A plant drainage system will be provided to allow all of the process units to be drained. All processes will be able to be drained to the Influent Pump Station wet well. The drains from the restrooms in the Operations Building also will be conveyed to the Influent Pump Station wet well.

NON-COMPLIANT EFFLUENT STORAGE TANK

Twenty-four hours of storage will be provided for non-compliant effluent in order to meet Title 22 requirements. The plant flow will automatically be diverted to this storage based on effluent turbidity. All plant overflows will be directed to this storage. The non-compliant effluent storage will have a high level overflow to the wet weather storage pond. The non-compliant effluent storage will have pumps to pump tank contents back to the secondary process. The spill containment area will also overflow to the noncompliant effluent storage tank.

AEROBIC DIGESTION AND DEWATERING

Solids from the activated sludge process will be aerobically digested and dewatered.

Aerobic Digestion

Solids from the activated sludge process will be directed to the aerobic digester. The aerobic digester will provide stabilization of the solids prior to dewatering. The aerobic digester will be designed to provide the detention time required to achieve needed solids reduction

Dewatering

Solids from the aerobic digester will be dewatered. After the solids have been dewatered they will be placed in a truck or bin and taken to a landfill. The belt press will be inside a building. The air within the building will be scrubbed through the aeration tank prior to discharge.

SPILL CONTAINMENT SYSTEM

The process area of the treatment plant contains piping, equipment and tankage. Overflows, pipe breaks or equipment failures could cause spills of sewage or partially treated sewage. To contain these spills and prevent them from exiting the site, the process area will drain to a single location. This location will have a normally closed valved connection to the storm drain. Liquid accumulating in this area will normally flow to the non-compliant effluent storage tank. If it rains the valve can be opened to direct the runoff to the storm drain.

CHAPTER 5

SPRAY IRRIGATION AND WET WEATHER STORAGE

In this chapter we will discuss the acreage available on the Montecito Ranch project for spray irrigation of tertiary effluent and identify the needed wet weather storage of treated effluent.

Wet weather storage is required to impound recycled water during periods of time when irrigation is not feasible. The method of effluent disposal within the proposed Montecito Ranch Sewer Maintenance District is spray irrigation and landscape irrigation. The sewer maintenance district will not own or operate landscape irrigation systems. All landscape irrigation systems will be owned and maintained by other entities such as the home owners association, a County Landscape Maintenance District LMD), or other entity approved by the Director of Public Works. Thus all wastewater treated on the project will be treated to a tertiary level and reused within the project.

The proposed Montecito Ranch Sewer Maintenance District will generate 118.4 acre-feet per year of recycled water based upon the expected sewer generation for the Montecito Ranch project.

SUMMARY OF IRRIGATION AREAS

The proposed Montecito Ranch Sewer Maintenance District will use a spray disposal area as well as landscaped parks, slopes, and greenbelts for disposal of treated effluent from the wastewater reclamation plant. A dedicated spray disposal field is incorporated into the site planning for the Montecito Ranch Wastewater Reclamation Plant. A total of 17.0 acres of land is being allocated for spray disposal purposes. This land is adjacent to the wastewater reclamation plant site and directly to the east of it. Figure 5-1 shows all the landscape irrigation areas within the Montecito Ranch project as well as the spray disposal fields

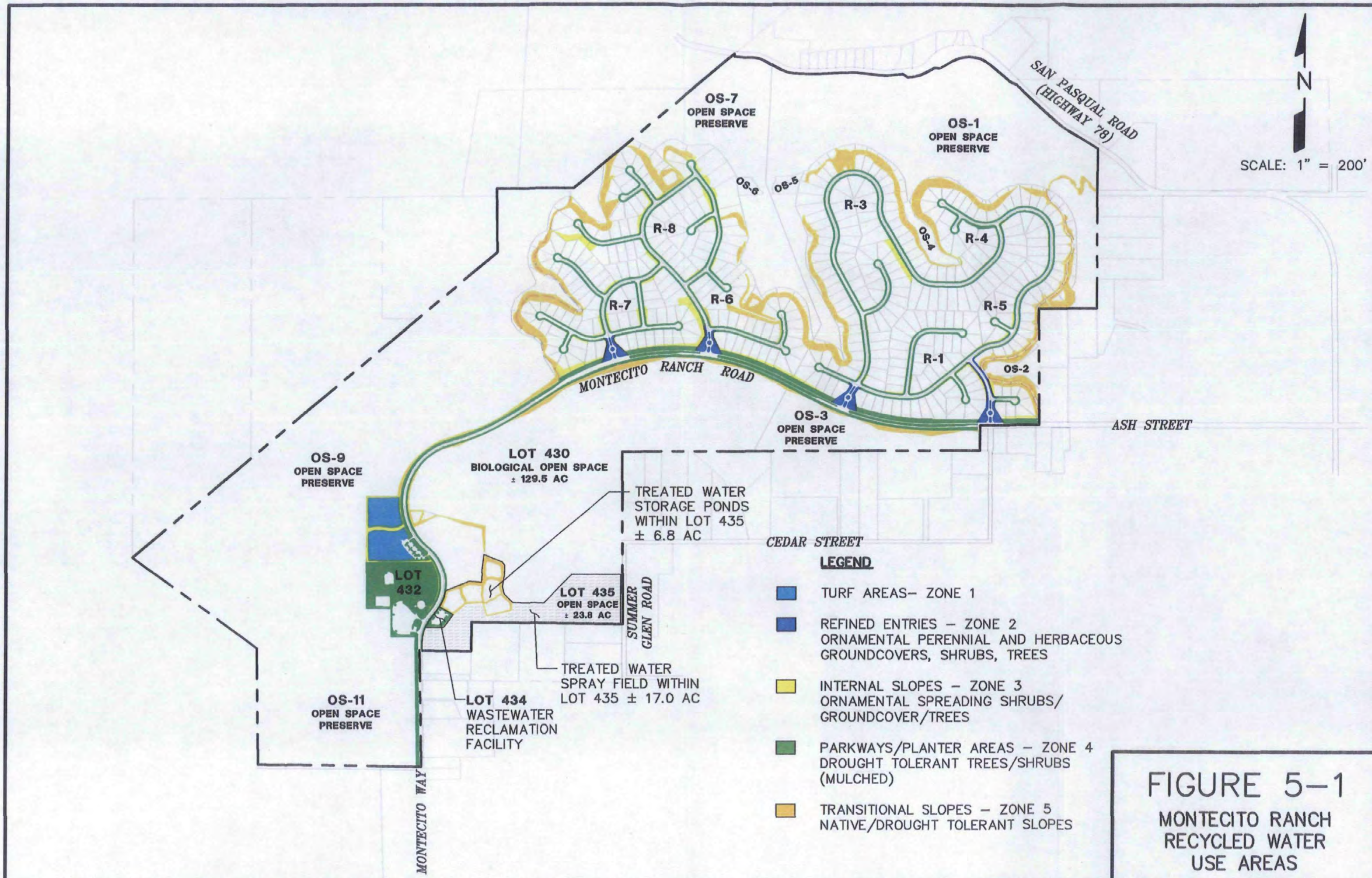

FIGURE 5–1
MONTECITO RANCH RECYCLED WATER USE AREAS

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Recycled water is proposed to be used within the Montecito Ranch project in order to offset the need for potable water supplies and provide additional means for disposal of the treated effluent generated at the wastewater reclamation plant. Irrigation areas include manufactured slopes, streetscapes, parks, and screening plantings for the wastewater reclamation plant. Thus, in combination with the dedicated spray irrigation fields, the total acreage available for irrigation within the Montecito Ranch project is about 98.1 acres. This acreage is summarized in Table 5-1. The total irrigation demand is 260.7 acre-feet/year. The dedicated disposal area could be used to dispose of an additional85.0 acre-feet/year.

TABLE 5-1[1]
MONTECITO RANCH RECYCLED WATER IRRIGATION ACREAGE AND WATER NEEDS

Planting Type	Zone	Acres	Application Rate, inches/year	Yearly Water Need, acre-feet/year
Turf	1	5.9	66"	32.4
Ornamental	2	2.5	57"	11.7
Ornamental	3	8.8	49"	36.0
Parkways	4	26.1	41"	89.3
Slopes	5	37.8	29"	91.3
Subtotal		**81.1**		**260.7**
Spray Disposal Field		17.0	60"	85.0
Total		**98.1**		**345.7**

[1]See Appendix C for Landscape Water Requirements Worksheet.

MAKE-UP WATER

Since the irrigation demand of 260.7 acre-feet/year is greater than the recycled water produced of 118.4 acre-feet/year, additional water will need to be provided to the recycled water system. This water will have to be provided from the potable water system. This potable make-up supply will require an air gap system for backflow prevention and repumping of the water. The irrigation demands will be re-evaluated at time of water reclamation plant plan submittal to the County. Make-up water will be provided by groundwater wells or potable water from the Ramona Municipal Water District.

WET WEATHER STORAGE

Table 5-2 provides a summary month-by-month of the wet weather storage requirements needed for the proposed Montecito Ranch Sewer Maintenance District. A day by day analysis is included in Appendix D. This analysis was prepared using the 1977-78 winter which is the wettest winter on record in Ramona.

As Table 5-2 shows, the maximum amount of storage needed occurs in April. The required storage volume is 25.98 acre-feet; at a wastewater reclamation plant flow rate of 105.670 gpd, the storage required amounts to 80.1 days of storage. The storage volume currently planned for the wet weather storage ponds adjacent to the water reclamation plant will be designed for 84 days of storage. This calculation is considered to be preliminary; the storage volume will be based upon the final landscaping plans for the Montecito Ranch project and subject to review by the County of San Diego and the San Diego Regional Water Quality Control Board.

TABLE 5-2
MONTECITO RANCH PROJECT
WET WEATHER STORAGE REQUIREMENTS

Month	Rainfall[2]		Effluent[3] Production, Acre-Feet	Irrigation Need		Maximum Storage Needed, Acre-Feet
	Inches	Acre-Feet[1]		Percent	Acre-Feet	
October	0.23	1.9	9.9	11.9	41.1	0
November	0.02	0.2	9.6	5.5	19.0	0
December	2.92	23.9	9.9	4.4	15.2	4.48
January	13.06	106.7	9.9	1.8	6.2	13.20
February	5.83	47.6	9.0	5.8	20.1	18.24
March	9.53	77.8	9.9	6.5	22.5	20.48
April	1.70	13.9	9.6	5.1	17.6	25.98
May	0.34	2.8	9.9	7.5	25.9	24.85
June	0.00	0.00	9.6	10.2	35.3	10.47
July	0.00	0.00	9.9	14.1	48.7	0
August	0.00	0.00	9.9	15.6	53.9	0
September	1.17	9.6	9.6	11.6	40.1	0
TOTAL	**34.80**		**116.7**	**100%**	**345.6**	

[1]Based on 98.1 acres
[2]Based on 1977-78 winter
[3]Based on 105,670 gpd (0.32 acre-feet/day)

CHAPTER 6

REGULATORY REQUIREMENTS

A number of permitting agencies will need to review and permit elements of the collection, treatment, and disposal system for the proposed Montecito Ranch Sewer Maintenance District. The San Diego Regional Water Quality Control Board, the State Health Department, the County Health Department and other agencies will be involved with the project.

SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

The San Diego Regional Water Quality Control Board will issue waste discharge permits for the wastewater reclamation plant and the sewage collection system.

Collection System

The operation and maintenance of the sewage collection system of the proposed Montecito Ranch Sewer Maintenance District will be governed by Waste Discharge Requirements (WDR) issued by the State Water Resources Control Board and the San Diego Regional Water Quality Control Board. This permit will require a Spill Prevention Plan and a Spill ResponsePlan.

Treatment Plant

The proposed Montecito Ranch Sewer Maintenance District will need to apply for a waste discharge permit for the wastewater reclamation plant. The plant will be located in Hydrologic Basin Unit Number 5.40, The Santa Maria Valley. Table 6-1 provides a summary of the groundwater objectives for this area.

TABLE 6-1 GROUNDWATER OBJECTIVES FOR HYDROLOGIC BASIN UNIT NUMBER 5.40	
Parameter	**Objective, mg/L**
TDS	1,000
Cl	400
SO_4	500
NO_3	10
Fe	0.3
Mn	0.05
B	0.75
Na	60%[1]

[1]Percent Na is found as follows $\% Na = \frac{Na}{Na + Ca + Mg + K} \times 100$

In order to meet these objectives and provide treated effluent suitable for reclamation, the proposed Montecito Ranch Sewer Maintenance District may need to impose a ban on self regenerating water softeners.

It is anticipated that a turbidity limit of 2.0 NTU will be required if filters are used and 0.2 NTU units if membranes are used. The current Master Reclamation Permit for Ramona Municipal Water District's Santa Maria plant does not contain an odor, color or MBAS limit.

STATE HEALTH DEPARTMENT

The effluent from the wastewater treatment plant will need to meet the requirements of Title 22 of the State Health Department for unrestricted reuse. Some onsite testing of the disinfection system will likely be needed prior to distribution and use of the recycled water.

COUNTY HEALTH DEPARTMENT

The recycled water piping and distribution system will need approval by the County Health Department.

OTHER AGENCIES

The County of San Diego Air Pollution Control District will need to issue a permit for each emergency power diesel generator to be used within the proposed Montecito Ranch Sewer Maintenance District. A permit will also be needed for all hazardous chemicals.

CHAPTER 7

JURISDICTIONAL CONSIDERATIONS

Formation of a Sewer Maintenance District will be proposed as the public entity which will own, operate, and maintain the sewage system. In this chapter the formation and responsibilities of the Sewer Maintenance District are discussed.

Formation of any new sewer maintenance district must be approved by the County Board of Supervisors. Should the Board of Supervisors approve formation of a sewer maintenance district or other dependent County special district to provide sewer service to the project, financial and operational agreements for the proposed sewer collection, treatment, and disposal facilities will be required and made conditions of the Montecito Ranch project approval.

FORMATION OF THE SEWER MAINTENANCE DISTRICT

Concurrent with the EIR certification and project approvals, the County Board of Supervisors will consider formalizing the intent to form a Sewer Maintenance District. After formation of the District, the District will need to adopt the County uniform sewer ordinance and a fee schedule to provide for the administration of the District.

County of San Diego Board Policy I-78

The Board of Supervisors of San Diego County enacted Policy Number I-78 regarding small wastewater treatment facilities in order to establish guidelines for the use of such facilities. The purpose of the Board Policy is to prevent the extension of urban services into Estateand Rural land use categories.

The proposed Montecito Ranch Wastewater Reclamation Plant complies with Board Policy I-78 in that the proposed treatment plant capacity of 0.106 mgd is less than the definition of a small treatment plant which is 0.48 mgd. Secondly, the Montecito Ranch project is within one mile of the Urban Limit Line which satisfies the concern that urban services not be extended into low density land uses.

OPERATION, MAINTENANCE, AND ADMINISTRATION

The proposed Montecito Ranch Sewer Maintenance District could utilize County staff for operation, maintenance and administration of the District, or all or part of these services could be provided by contract. The contracts for providing services could be with other public agencies or a private company.

OWNERSHIP OF FACILITIES

The collection, treatment, and effluent wet weather storage system are proposed to be owned and operated by the proposed Montecito Ranch Sewer Maintenance District. The recycled water distribution system could be owned and operated by the Sewer Maintenance District or another public entity.

CHAPTER 8

PRELIMINARY USER FEE AND FISCAL ANALYSIS

In this chapter a fiscal analysis of the wastewater reclamation plant is provided to assist with the establishment of user fees for the proposed Montecito Ranch Sewer Maintenance District. Operation costs, capital replacement costs, and occupancy schedules are provided to give an overall fiscal analysis of the start-up of the Montecito Ranch Wastewater Reclamation Plant. Final rate analysis and developer fees including a cost sharing agreements will be based on detailed financing studies to be conducted as part of the facilities planning and feasibility studies.

OPERATION AND REPLACEMENT COSTS

Table 8-1 provides an estimate of the yearly cost of operation of the Montecito Ranch Wastewater Reclamation facilities. The estimated yearly operational and replacement cost is $1,099,300. This includes operating expenses of $849,300 and capital replacement contribution of $250,000 per year. Based on this yearly cost and the total EDU count of 440, the annual fee per user is approximately $2,500 ($208 per month). This cost is high when compared to other sewer service agencies. Table 8-2 provides a comparison of local agencysewer service costs.

OCCUPANCY SCHEDULE

Table 8-3 provides an occupancy schedule for the project based on a five-year buildout. This occupancy schedule assumes that there would be 417 residential dwelling units plus 23 EDUs from the treatment plant and parks in the project. It also assumes a maximum yearly occupancy rate of 100 EDUs which would occur in the fourth year. It is assumed that the first year will have approximately 50 occupancies.

FISCAL ANALYSIS

Table 8-3 provides a fiscal analysis of the first six years of the project. This schedule is based on an arbitrary Year One which would be the first year houses are occupied within the Montecito Ranch project. As can be seen in the table, the project becomes self-funding at Year Six.

TABLE 8-1
YEARLY OPERATION AND MAINTENANCE
COSTS AT BUILD OUT (INCLUDES PUMP STATIONS)

Expenditures	Budget
Operations	
Treatment Plant Labor, 60 hours per week @ $115/hr	$358,800
Power (110,000 kWh[1] @ $0.20/kWh	$22,000
Water, $50 per month	$600
Telephone and Alarm Monitoring, $200 per month	$2,400
Chemical and Consumables, $5,000 per month	$60,000
Minor Equipment and Tools	$1,000
Laboratory, $15,000 per quarter	$60,000
Permit Fees (Regional Water Quality Control Board fee)	$12,500
Sewer Cleaning	$25,000
Sludge Disposal, $500 per week	$26,000
Collection System Investigation, Repair and Emergency Spill Response, 3 events per year @ $10,00 each	$30,000
Equipment Repair and Maintenance	$50,000
Trash Disposal	$12,000
Vehicle Expenses, $1,000 per month	$12,000
Sub-Total Operations Expenditures	**$672,300**
Administrative	
Management, 20 hrs month @ $175/hr	$42,000
Professional Services – Engineering	$25,000
Insurance	$100,000
Contingency/Miscellaneous	$10,000
Sub-Total Administration Expenditures	**$177,000**
Capital Replacement[2]	**$250,000**
TOTAL EXPENDITURES	**$1,099,300**

[1]See Appendix E Power Use Calculations
[2]This is based on a treatment plant cost of $3.5M and sewage lift stations cost of $1.5M and a 20 year life with no interest or inflation calculation.

TABLE 8-2 COMPARISON OF ANNUAL SEWER SERVICE COSTS	
Agency	**Annual Cost per EDU**
Leucadia Wastewater District	$235
City of San Diego	$535
City of Escondido	$517
Ramona Municipal Water District	$513
Valley Center MWD – Woods Valley Service Area	$1,183
Fairbanks Ranch	$990
Julian	$671
Proposed Montecito Ranch	$2,500

A number of assumptions are built into Table 8-3 which should be pointed out. The first assumption is that in Year One there are no operational costs for the plant because it is not as yet turned on. Sewage for all the Year One dwelling units is being hauled and treated at an alternate location at no cost to the County while the contractor is still constructing the plant. Thus, wastewater treatment plant operational costs do not start until Year Two. The first year cost for sewage trucking offsite is not included in the Table 8-3 fiscal analysis. Year One does include an estimate of Operational Costs for the sewage lift stations.

The table also shows the delay of funding of the capital reserve until Year Five. This is to allow the user fees to pay the greatest portion of the operation of the plant in the early years. As can be seen in the table, even with these assumptions there is a $1,457,500 gap fee that must be funded by the developer.

The fiscal analysis presented in Table 8-3 is a feasibility-level analysis only. The final cost arrangement with the developer will be included in a negotiated cost sharing agreement between the developer and the County. The Cost Sharing Agreement, approved by the County, will include, but not be limited to, indefinite securitized gap funding as well as developer contributions to operating and maintenance and replacement reserve funds until the proposed subdivision development project is built-out.

TABLE 8-3
MONTECITO RANCH WASTEWATER FACILITIES
FISCAL ANALYSIS

Year of Operation	Cumulative Total	1	2	3	4	5	6
EDUs							
Residential Occupancy	417	50	75	95	100	97	
Other EDUs	23	5	7	6	5		
Total EDUs	**440**	**55**	**82**	**101**	**105**	**97**	**440**
Users Getting Bills			**55**	**137**	**238**	**343**	**440**
Expenses							
Operating Expenses		40,000*	700,000	750,000	800,000	849,300	849,300
Capital Reserve**						250,000	250,000
Total Expenses		**40,000**	**700,000**	**750,000**	**800,000**	**1,099,300**	**1,099,300**
Revenue							
User Fee***			137,500	342,500	595,000	857,500	1,100,000
Gap fee by Developer	**1,457,500**	40,000	562,500	407,500	205,000	242,500	0
Total Revenue******		**40,000**	**700,000**	**750,000**	**800,000**	**1,100,000**	**1,100,000**
Income In Excess of Expenses		-	-	-	-	-	

*Operational cost for sewage lift stations estimated at 25% of build-out operational costs.

**Accounts for capital replacement of treatment plant, and two lift stations. Does not include fees for initial offsite disposal.

*** User fee $2,500 per unit per year.

****Revenue is based on sewer related income only; income from sale of recycled water product is not included.

APPENDIX A

COUNTY OF SAN DIEGO
ORDINANCE 9103

ORDINANCE NO. 9103 (NEW SERIES)

AN ORDINANCE REPEALING AND READOPTING THE SAN DIEGO COUNTY UNIFORM SEWER ORDINANCE, PROVIDING FOR THE MANAGEMENT OF DEPENDENT SAN DIEGO COUNTY SANITATION DISTRICTS AND ESTABLISHING PROVISIONS FOR THE USE OF SEWERAGE FACILITIES OF COUNTY SANITATION DISTRICTS AND SEWER MAINTENANCE DISTRICTS,

The Board of Supervisors of the County of San Diego ordains as follows:

Section I. The San Diego County Uniform Sewer Ordinance (#8883) is repealed. The repeal of said Ordinance shall not result in the termination of any liens against any lot or parcel of land against which any charges have been imposed pursuant to said Ordinance.

Section II. The San Diego County Uniform Sewer Ordinance is adopted to read as follows:

Section III. Purpose and Policy

The purpose of this ordinance is to provide for the maximum public benefit from the use of Sanitation or Sewer Maintenance District's facilities, hereafter referred to as "District". This shall be accomplished by regulating sewer use and wastewater discharges, by providing equitable distribution of District's costs and by providing procedures that will allow the District to comply with the requirements placed upon the District by other regulatory agencies. The revenues to be derived from the application of this Ordinance shall be used to defray all costs of providing sewage service by the District, including, but not limited to, administration, operation, monitoring, maintenance, financing, capital construction, replacement and recovery, and provisions for necessary reserves.

This Ordinance shall be interpreted in accordance with the definitions set forth in Article II. The provisions of the Ordinance shall apply to the direct or indirect discharge of all wastewater carried by, and to, facilities of the District.

To comply with Federal and State of California policies to permit the District to meet applicable standards of treatment plant effluent quality, provisions are made in this Ordinance for the regulation of wastewater discharges. This Ordinance establishes quantity and quality limitations on all wastewater discharges that may adversely affect District sewerage systems treatment processes, or effluent quality. It is the intent of these limitations to improve the quality of wastewater received for treatment. This Ordinance also provides for the regulation of the degree of wastewater pre-treatment required, the issuance of permits for wastewater discharge and the establishment of penalties for violations.

Section IV. Enactment

PARTS I AND II of the San Diego County Uniform Sewer Ordinances are enacted to read as follows:

PART I- FEES AND SEWER CAPACITY DETERMINATION

Article 1- General Provisions

1.1 Provisions not affected by Headings. Article and section headings contained herein shall not be deemed to govern, limit or modify, or in any manner affect the scope, meaning or intent of any section hereof.

1.2 Tenses. The present tense includes the past and future tenses; and the future, the present.

1.3 Number. The singular number includes the plural, and the plural includes the singular.

1.4 "Shall and May". "Shall" is mandatory and "may" is permissive.

1.5 Authority. The fees and charges referred to in this Ordinance are adopted pursuant to Sections 5470 and 5471 of the Health and Safety Code of the State of California.

Article 2- Definitions

2.1 Signification of Words. Whenever in this Ordinance the following terms are used, they shall have the meaning respectively ascribed to them in this article.

2.2 The following definitions shall relate to all occurrences of the terms listed below.

1. "Available Sewer Capacity" is the remaining uncommitted sewer capacity composed of contract sewer capacity or physical sewer capacity, whichever is less, less committed sewer capacity.

2. "Board of Directors" of a Sanitation District shall mean the governing Board of such District provided by the Board of Supervisors of the County of San Diego.

3. "BOD" means biochemical oxygen demand. BOD relates to the strength of the wastewater directly effects the energy and cost of wastewater treatment. BOD values are one variable used in the determination of the annual sewer service charges for a specific use.

4. "Building Sewer" shall mean a sewer conveying wastewater from the premise of a user to the District sewer system.

5. "Capital Facility Capacity Fee" is the fee established as a method of purchasing a specified amount of available sewer capacity as determined by the Wastewater Discharge Permit.

6. "Commercial Condominium" shall mean any individual commercial office unit.

7. "Committed Sewer Capacity" is the sewer rights committed by issuing a validated wastewater discharge permit for the District or a sewer capacity commitment.

8. "Contract Sewer Capacity" is the District's contract average flow rights through the metropolitan sewerage system or any other sewerage system. (Added by Ord. 5345 N.S. Eff. 12 Feb 79 amended by Ord. 5412 N.S. Eff. 22 Mar 79)

9. "Department" shall mean the Department of Public Works of the County of San Diego.

10. "Director" shall mean the Director of the Department of Public Works, County of San Diego, State of California.

11. "District" shall mean each sanitation District and/or sewer maintenance District within the County of San Diego, including areas served by agreement, for which the County Board of Supervisors serves as the District's Board of Director.

12. "Equivalent Dwelling Unit (EDU)" shall mean the unit of measure that is based on the flow of characteristics of an average single family residence in terms of sewage quantity and constituent quality.

13. "Fiscal Year" shall mean the period from July 1, to the following June 30, both inclusive.

14. "Local Agency Formation Commission (LAFCO)" is the commission responsible for coordinating logical and timely changes in local governmental boundaries, including annexations and detachments of territory, incorporations of cities, formations of special districts, and consolidations, mergers, and dissolution of districts, as well as reviewing ways to reorganize, simplify, and streamline governmental structure.

15. "Person" shall mean any person, firm, company, corporation, political subdivision, municipal corporation, district, the State of California, the United States of America or any department or agency thereof.

16. "Physical Sewer Capacity" is the District's physical average flow ability through its own or another sewerage system.

17. "Premise" shall mean any lot, piece or parcel of land, building or establishment.

18. "Residential Condominium". (Unit) as used herein shall mean a distinct classification of user. Section 2188.3 of the Revenue and Taxation Code and Sections 783 and 1350 of the State of California Civil Code shall be used to classify units. Each condominium unit so identified shall be considered an individual permittee for the purposes of this ordinance.

19. "Sewer System" shall mean all facilities and appurtenant equipment utilized in the collection, transportation, pumping, treatment and final disposal of wastewater within the District.

20. "TSS" means total suspended solids. TSS values are one variable used in the determination of the annual sewer service charges for a specific use.

21. "Wastewater" shall mean all residential, commercial and industrial liquid wastes authorized for discharge into any collection system operated by the County of San Diego.

22. "Wastewater Discharge Permit" shall mean the written documentation allowing a user to connect and discharge wastewater to the District sewer collection system.

Article 3- Annexation and Detachment Fees

3.1 Annexation Fee. In addition to any other fees established by each District, including those fees established or to be collected pursuant to Chapter 2 (commencing with Section 68.201) Division 8 of Title 6 of the San Diego County Code of Regulatory County Ordinances, which Code is applicable to the territory within each District, annexation fees shall be paid in accordance with the following:

a. APPLICATION FEE. Territories annexed to the District shall pay application fees as established by the District and set forth in the fee ordinance of each district.

b. ANNEXATION FEE. In addition to the fee established in this Ordinance, each District shall establish an annexation use fee comprised of a fixed fee per acre (prorated for fractional acre lots). These fees shall be set forth in the District fee ordinance.

c. STATE BOARD OF EQUALIZATION FEE. Changes in jurisdictional boundaries must be mapped and reported to the State Board of Equalization. A processing fee is charged for this service.

3.2 Payment of Fees. The entire fee prescribed in this Section 3.1(a-c) of this Ordinance shall become owing, due and payable to the District at the time application is made to annex a premise to the individual District.

3.3 Refund of Annexation Fee. The annexation application fee per Section 3.1(a) covers administrative costs and is non-refundable. In the event the proposed annexation is discontinued, the annexation use fee established in Section 3.10(b) shall be refundable upon written request of the person who initiated the proposed annexation.

3.4 Detachment Fee. In addition to any other fees established by the District, including those fees established or to be collected pursuant to Chapter 2 (commencing with Section 68.201) of Division 8 of Title 6 of the San Diego County Code of Regulatory County Ordinances, which code is applicable to a territory within a District, a detachment fee shall be paid for territory requesting detachment from the District. This fee shall be set forth in the District fee ordinance and shall become owing, due and payable to the District at the time application is made to detach the territory from the District.

Article 4- Wastewater Discharge Permit Programs

4.1 Capital Facility Capacity Fees. In addition to any other fees for connections to the sewer system within a District, or through agreement with a District, including those fees established or to be collected pursuant to Chapter 2 (commencing with 68.201) of Division 8 of Title 6 of the San Diego County Code of Regulatory Ordinances which code is applicable to all Districts, a Capital Facility Capacity Fee for District sewer capacity shall be established by each District and shall be set forth in the Fee Ordinance.

(a) The Capacity Fee shall be applied to each equivalent dwelling unit connected to the sewer system of a District after the effective date of this Ordinance. The number of equivalent dwelling units prescribed herein shall be used to compute the amount of the Capital Facility Capacity Fee.

(b) Changes in use resulting in increased sewer service charges and/or Capital Facility Capacity Fees: The nature and volume of discharge shall be limited to the type and number of equivalent dwelling units authorized by the wastewater discharge permit. Before adding any additional equivalent dwelling units, or buildings, or modifying existing buildings, or changing occupancy type, the property owner shall make a supplementary wastewater permit application to the District for such change in use and pay additional sewer fees, if necessary, as may be applicable.

Periodic inspection of the premises may be made by the District. If an unauthorized change in use is found, reassessment of edu's shall be made by the District and any appropriate additional Capital Facility Capacity Fees shall be assessed in accordance with this Ordinance and the current District Fee Ordinance.

(c) Commercial, professional, and industrial uses: The Capital Facility Capacity Fee for District sewer capacity for commercial, professional, or industrial uses shall be computed using the number of equivalent dwelling units prescribed herein.

(d) Miscellaneous fees in addition to the basic Capital Facility Capacity Fee may be established from time to time, for various special areas within a particular District, to reimburse the District for costs applicable only to these said special areas within the particular District.

(e) Capital Facility Capacity Fees and any special fees applicable shall be established by fee ordinance of the individual Districts. Information regarding these fees shall be made available to the public at the County of San Diego Department of Planning and Land Use (DPLU) and the Department of Public Works service counters.

4.2 Payment of Capital Facility Capacity Fees. The entire Capital Facility Capacity Fees prescribed in Sections 4.1 (a through e) inclusive, shall become owing, due and payable at the time application is made to connect a premise to the sewer system of the District. This fee shall be paid to the Department prior to the issuance of any permit authorizing the connection of such premise to the District's sewer system. If the proposed connection cannot be made, the fee may be refunded when approved by the Director.

4.2.1 Extreme Hardship Cases: At the discretion of the Director, the County of San Diego may approve payment plans for collection of Capital Facility Capacity Fees. Payment must be paid in full within 12 months. Customers must submit written request for establishment of a payment plan, including demonstration of extreme hardship.

4.3 Wastewater Discharge Permit Issuance and Limitation. Pursuant to Chapter 2 (commencing with Section 68.201) Division 8 of Title 6 of the San Diego County Code of Regulatory County Ordinances, which code is applicable within each District, a wastewater discharge permit shall be required for any property or business discharging into the District's sewerage system.

For new construction, a wastewater discharge permit is valid for the same time period as the building permit. That period is one year from the date of issuance of the building permit, if building or sewerage construction work has commenced. If an extension is granted for the building permit, that same extension shall apply to the wastewater discharge permit. If construction or work authorized by such permit is suspended or abandoned for a period of one year any time after the work is commenced, then the permit shall expire.

Before such work can be recommenced, a new wastewater discharge connection application must be filed with the Department of Planning and Land Use. The District may reactivate the previous wastewater discharge permit provided that wastewater quantity and type is the same as the wastewater discharge allowed under the original permit, and provided further that the applicant has paid any cost difference between prior connection Capital Facility Capacity Fee and the current Capital Facility Capacity Fee. Fees paid for the previous wastewater discharge permit may be credited toward the total permit fees required on the new permit application.

Reactivation of the previous wastewater discharge permit shall be subject to District sewerage capacity being available at the time of new application.

Article 5- Establishment of Sewer Service Charge

5.1 Establishment of Sewer Service Charge There is hereby levied and assessed upon each premise in the various Districts that discharge sewage directly or indirectly into the sewer lines of the District, and upon each person owning, letting, or occupying such premise an annual sewer service charge.

(a) Metro Sanitation Districts:
The Annual Sewer Service Charge is made up of two components. The first component is based on the District's annual cost to collect and transport wastewater, and is equally divided among the number of equivalent dwelling units connected to the District's system. The second component is the District's cost for wastewater treatment and disposal as fees paid to the City of San Diego for capacity and use of the San Diego Metropolitan Sewer System. This factor is allocated to users of the District's system based on the users generation of annual wastewater flow, biochemical oxygen demand and suspended solids discharged into the District's system.

(b) Non-Metro Sanitation Districts:
The Annual Sewer Service Charge is based on the District's annual cost for operation and maintenance of the District facilities, treatment and disposal of wastewater and capital improvement projects. These costs are equally divided among the number of equivalent dwelling units connected to the District's system.

For the purpose of this ordinance, the discharge characteristics of commercial/industrial users is a minimum sewer capacity of 1.2 EDU for each business unit with flow quantity and strength as measured by BOD and SS, as set forth in the current edition of the California State Water Resources Control Board publication, "Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment Facilities", or comparable industry standards acceptable to the California State Water Resource Control Board and approved by the Director.

The EDUs are determined for individual business units as set forth and are applicable to each of the various Districts under the jurisdiction of this Ordinance. The Director shall assign flow rates, BOD, and SS based upon the estimated amount of and strength of wastewater that is typically generated for each business unit. The EDUs, flow rates, BOD, and SS so assigned shall be used in computing the sewer service charges.

If potable water delivered through the water meter is used by the District to estimate the volume of wastewater discharged over a period of time, then 100% of water meter flow is estimated to be discharged into the sewer unless the discharger or legal owner presents evidence to the contrary and this evidence is satisfactory to the Director. The Director may adjust the charges for wastewater treatment and disposal in proportion to the estimated volume of wastewater discharged to the sewer.

5.2 FORMULA FOR DETERMINING SEWER SERVICE CHARGES (SSC).

$$SSC = \frac{n}{N} x D + \frac{f}{F} x\ M_F + \frac{b}{B} x\ M_B + \frac{s}{S} x\ M_S$$

Annual Sewer Service charges shall be determined by the formula (rounded to the nearest dollar).

In the above formula the symbols have the following meanings and definitions:

n = Number of equivalent dwelling units (EDUs) assigned to a particular user. EDUs are assigned in accordance with the Uniform Sewerage Ordinance.

f = Flow of a particular user in million gallons per year, based either upon assigned EDUs or water meter records.

b = BOD of a particular user in pounds per year, based either upon State standards or comparable industry standards approved by the State.

s = Suspended solids of a particular user in pounds per year, based either upon State standards or comparable industry standards approved by the State.

N = Total number of EDUs in the District. This is a summation of the EDUs assigned to all users, based upon the Uniform Sewerage Ordinance.

D = District budgeted costs for the fiscal year in dollars, to collect and transport wastewater. This is the net cost for District customers after the revenues from Out - of- District-Users have been subtracted from the total District Budget Cost. Such cost shall include, but not be limited to operation and maintenance costs of pipelines, pump stations, and meter stations; design and construction cost of replacement facilities; and administration costs including fee collections, accounting, record maintenance, planning and code enforcement.

M = Total District budgeted cost for the fiscal year in dollars, for treatment and disposal of wastewater. Such cost shall include, but not necessarily be limited to, fees paid to the City of San Diego for capacity in and use of Metro System. The Metro treatment and disposal cost are further divided into cost categories as follows: Flow Cost M_F ; BOD Cost = M_B ; SS COST = M_S.

F = Total flow in the District in million gallons per year from summation of users BOD loadings, based upon either State standards, or comparable industry standards approved by the State.

B = Total BOD in the District in pounds per year, from a summation of users BOD loadings, based upon either State standards, or comparable industry standards approved by the State.

S = Total Suspended Solids in the District in pounds per years, from a summation of users, TSS loadings, based either upon State standards, or comparable industry standards approved by the State.

5.3 Assignment of sewer capacity for residential structures. Each residential structure shall have a separate, individual sewer lateral that shall connect to the District's system. Sewer capacity shall be assigned in terms of Equivalent Dwelling Unit(s) as follows:

		EDU
a.	Single Family Residence (Includes manufactured homes, and mobile homes which are on separate private lots)	1.0
b.	Apartments and Multiple Family Housing. Each individual living unit, regardless of number of bedrooms.	0.80
c.	Residential condominiums. Each individual living unit	1.0
d.	Mobile Home and Trailer Parks, per each individual living space:	
	1. Mobile Home Space	0.65
	2. Trailer Space	0.65
	3. Recreational Vehicle Park, occupied or not.	0.65

5.4 COMMERCIAL/INDUSTRIAL FACILITIES.

a. Food Service Establishments

		EDUs
1.	Take-out restaurants with disposable utensils, no dishwasher, and no public rest rooms	3.0
2.	Miscellaneous food establishments - ice-cream/yogurt	3.0
3.	Take out/eat-in restaurants	
	(a) with disposable utensils, but with seating and public rest rooms.	3.0 minimum
	(b) Restaurants with re-usable utensils, seating and public Restrooms	3.0 minimum
	One EDU is assigned for each 6 seat unit as follows:	3.0
	Each additional 6-seat unit will be assigned	1.0

b. Hotels and Motels

1.	Per living unit without kitchen	0.38
2.	Per living unit with kitchen	0.60

c. Commercial, Professional, Industrial Buildings. Establishments not specifically listed herein

1.	Any office, store, or industrial condominium or Establishment. First 1,000 sq. ft.	1.2
	Each additional 1,000 sq. ft. or portion thereof	0.7

2. Where occupancy type or usage is unknown at The time of application for service, the following EDUs shall apply. This shall include but not be Limited to shopping centers, industrial parks, And professional office buildings.

First 1,000 square feet of gross building floor area.	1.2
Each additional 1,000 square feet of gross building floor area. Portions less than 1,000 square feet will be prorated.	0.7

d. Churches, theaters and auditoriums

Per each 150 person seating capacity, or any fraction thereof.	1.5

(Does not include office spaces, school rooms, day Care facilities, food preparation areas, etc. Additional EDUs will be assigned for these supplementary uses.)

e. Schools

Elementary schools. For 50 pupils or fewer.	1.0
Junior High Schools. For 40 pupils or fewer.	1.0
High Schools. For 24 pupils or fewer.	1.0

Additional EDUs will be prorated based on above values.

The number of pupils shall be based on the average daily attendance of pupils at the school during the preceding Fiscal year, computed in accordance with the Education Code of the State of California. However, where the school has had no attendance during the preceding fiscal year,

The Director shall estimate the average daily attendance
For the fiscal year for which the fee is to be paid and compute
The fee based on such estimate

f. Convalescent Homes

1. Skilled nursing care facilities, psychological hospitals, Convalescent hospitals; licensed by the County of San Diego Health and Human Services Agency 0.7/bed

2. Community Care Facilities licensed by the County of San Diego 0.5/bed

3. Community Care Homes with six or fewer total residents, Including resident staff and housekeepers (to be the same EDU as a single family residence) 1.0

g. Other

In the case of commercial, industrial and other business establishments such as bottling works, supermarkets, markets, deli/markets, convenience stores, hospitals, laundries, automobile service stations, equivalent dwelling units shall be determined in each case by the Director and shall be based upon the estimated volume and type of wastewater discharge into the sewer.

5.4.1 The EDU designation for the specific commercial/industrial uses described in section 5.4 shall be used when no information is available regarding the actual discharge volume of the user. When determining the necessary sewer capacity requirements for a specific use, the County of San Diego has the discretion to use any information available to reach an accurate, justifiable capacity determination.

5.5 Payment of Annual Sewer Service Charges:

5.5.1 The County of San Diego collects initial Annual Sewer Service Charge payment when the Wastewater Discharge Permit and Building Permit charges are collected. In cases where no Building Permit is involved, as when changing from septic to sewer, the Annual Sewer Service Charge is collected with the associated Wastewater Discharge Permit Charges.

5.5.2 Initial payment of Annual Sewer Service Charge is prorated utilizing a fiscal year of July to June. The two months following the date of application are deducted. Permits issued beginning March first include sewer service charges for May and June plus the next succeeding fiscal year equaling 14/12ths of Annual Sewer Service Charge. The pro-ration is reduced by 1/12 each month until it reaches 3/12ths.

5.5.3 Thereafter, the Annual Sewer Service Charge for such premise shall be collected with the taxes of the District as authorized by this ordinance.

5.5.4 Government agencies not receiving tax bills will be invoiced in August for their annual sewer service charge.

5.5.5 If a use increases, and therefore the Annual Sewer Service Charge increases, the initial year difference is paid with a supplemental Wastewater Discharge Permit. Thereafter, the Annual Sewer Service Charge shall be collected with the taxes of the District or invoiced if the use is a governmental agency. In the event a supplemental permit is not purchased for the increased use, the Annual Sewer Service Charge shall be collected either with taxes when the use is a private business or invoiced when the use is a governmental agency.

5.6 Changes in Discharges Resulting in Increased Rate. Whenever the discharge of any premise is changed in either quantity or quality or both so that there is an increased Sewer Service Charge applicable to such premises, as determined by the Director, the District shall notify the owner of the premise in writing of the charge. Upon receipt of this notice there shall become owing, due and payable the prorated amount of the increased rate applicable to the premise for the remainder of the fiscal year in which the charge is made. The charge imposed by this section shall become delinquent sixty days following the date it becomes due.

Article 6- Miscellaneous Provisions

6.1 Sewerage Construction Provisions. Plans shall meet the County of San Diego's "Minimum Standard Specifications for Sewer Construction". Inspection of all sewerage construction shall be made by District personnel in the manner described in Part II, Section 102, of the County Standard Specifications.

In addition, the County minimum standards for sewer construction will be used to specify the maximum allowable infiltration/exfiltration rate for new sewers.

6.2 Users Outside the District. The Board of Directors of a District may establish by agreement or resolution the fees and charges and such other conditions as may be necessary. The same shall be imposed for providing sewer service to premises located outside of the District provided that such fees and charges shall not be less than would apply to similar services within the District. Any extension of sewer outside the District shall be subject to LAFCO approval as appropriate and shall not be in violation of any Board of Supervisors Policy.

6.3 Modification of Fees and Charges. The fees and charges established by this ordinance or by each District fee ordinance may be modified or amended by resolution of the District Board of Directors. New fees and charges shall be proposed by the Director and by the Board of Directors of the various Districts.

6.4 Deposit and Expenditure of Fees and Charges. All fees and charges collected pursuant to each District fee ordinance shall be deposited in the revenue fund of the District.

6.5 Use of District's Facilities Prohibited unless Fees and Charges Paid. No person shall discharge, or allow the discharge of, or dump sewage or other waste matter into a District's sewerage system except when in compliance with the terms of this ordinance and payment of the fees and charges provided and established by or pursuant to a District's fee ordinance.

6.6 Director to Enforce Ordinance. The Director is charged with the duty of enforcing the provisions of this ordinance and the rules and regulations adopted as herein provided.

6.7 Enforcement Measures in case of Delinquency. When any fee or charge imposed by this ordinance becomes delinquent, the Director is authorized to take any or all of the following actions:

a. Steps authorized by law to collect such fees and charges, including collection of a basic penalty of 10% for nonpayment of the charges herein imposed within the time and in the manner prescribed, and in addition, a penalty of one-half of 1% per month for nonpayment of said charges and basic penalty.

b. Disconnect the premise from the district's sewerage system, provided, however, that prior to such disconnection at least five (5) days written notice of such disconnection shall be given to the occupant of the premise by United States mail or by posting such notice on the premise. When a premise has been disconnected, it shall not be reconnected until all delinquent fees and charges have been paid together with reasonable charge for disconnection and reconnection as established by the Director, plus the penalties provided herein.

6.8 Unlawful to make Sewer Connection Without Payment of Fee. It shall be unlawful for any person to connect any building to a District's sewerage system without first paying the fees prescribed by the District fee ordinance.

6.9 Appeal Procedure
All appeals for reconsideration of Annual Sewer Service Charges must be made in writing. Any decision made by the Director shall be final.

a. Single Family Residence: Property owners shall not be eligible to appeal the base rate of 1.0 edu's. The only instances when the base rate may be waived is if the structure has been demolished and only a vacant lot remains, or the dwelling has no connection to the District sewer.

b. Multi-Family Residence: Property owners may request a re-consideration of their Annual Sewer Service Charge. The request must set forth the details and facts supporting the applicant's appeal. Water utility records may be required to support the appeal before rendering a decision.

Residential condominiums that are utilized as apartments and rented or leased may qualify for an adjustment to the condominium EDU factor under this appeal procedure. If approved by the Director, apartment EDU factors would then apply until the units are sold individually. See Article 5 for the current EDU factors. Once each unit is sold to an individual owner, the condominium rate would then apply to that unit.

c. Commercial/Industrial Facilities: Property owners may request a re-consideration of their Annual Sewer Service Charge. The request must set forth the details and facts supporting the applicant's appeal. Occupancy factors and water consumption data shall be considered before rendering a decision on the applicant's appeal. Commercial buildings or commercial condominiums that share a common bathroom may qualify for an EDU adjustment comparable to residential apartment units.

Once a property owner appeals the sewer service charge, the water records and occupancy information will continually be collected for that property in February/ March of each year. This will eliminate the need for any further appeals for that property.

Article 7- Fees and Charges may be Collected with Taxes

7.1 Collection on Tax Roll. Notwithstanding any other provision of this ordinance, the sewer service charges imposed by Article V, may be collected on the tax roll in the same manner and together with the general taxes of the District pursuant to Section 5473 through 5473.11, inclusive, of the Health and Safety Code of the State of California.

PART II- RULES AND REGULATIONS FOR USE OF DISTRICT SEWERAGE FACILITIES

Article 1 - Authority
The Director is charged with enforcing all applicable State, Federal, Local laws, and ordinances regarding discharge of wastewater into the sewer systems under his jurisdiction and all the provisions of this Ordinance.

This legal authority is established and binding for industrial users and enforceable by contract law or police powers. The Director of is assigned the authority to enforce this Ordinance, through his designee under one or more of the following ordinances:

1. County Code of Regulatory Ordinances Section 68.160

2. County Uniform Sewerage Ordinance 8883

3. City of San Diego Municipal Code, Chapter I, Article 2, Sections 12.0803 to 12.0810 and Chapter VI, Article 4, Sections 64.0100 to 64.0519.

Article 2 - Purpose
2.1. Purpose. This Ordinance sets forth uniform requirements for direct and indirect contributors into the wastewater collection and treatment systems operated by the County of San Diego Department of Public Works and enables the County of San Diego to comply with all applicable State of California and Federal laws required by the Clean Water Act of 1977 and subsequent Amendments and the General Pretreatment Regulations (40 CFR 403). This Ordinance shall apply to all sewerage districts that, by contract or agreement, are operated by the County of San Diego and are under the regulatory powers of the Director.

Article 3 - Definitions
3.1 Signification of Words. Unless otherwise defined herein, terms related to water quality shall be referred to as adopted in the latest edition of "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association and the Water Pollution Control Federation.

3.2 The following definitions shall relate to all occurrences of the terms listed below.

1. Act or "the Act". The Federal Water Pollution Control Act, also known as the Clean Water Act, as amended, 33 U.S.C. 1251, et seq.

2. "Approval Authority". For pretreatment, the administrator of the EPA, unless delegated to State of California Water Resources Control Board.

3. "Authorized User". An authorized representative of an Industrial User may be: (1) a principal executive officer of at least the level of vice- president, if the Industrial User is a corporation; (2) a general partner or proprietor if the Industrial User is a partnership or proprietorship, respectively; (3) a duly authorized representative of the individual designated above if such representative is responsible for the overall operation of the facilities from which the indirect discharge originates.

4. "B.O.D. (Denoting Biochemical Oxygen Demand)" shall mean the quantity of oxygen utilized in the biochemical oxidization of organic matter under standard laboratory procedure in 5 days at 20C. expressed in milligrams per liter.

5. "Categorical User" shall mean an industrial user having discharges as described in 40 Code of Federal Regulations, parts 410 through 471, and amendments thereof.

6. "Class I User" shall mean any Categorical User.

7. Class II User means any industrial or commercial user whose processes generate a waste stream that is discharged to sewer and contains toxic or non-conventional pollutants of concern.

8. "Class III User" means any industrial or commercial user whose processes generate a waste stream that is discharged to sewer and contains conventional pollutants.

9. "Conventional Pollutant" means a combination of biochemical oxygen demand, suspended solids, pH, fecal Coliform bacteria and oil and grease.

10. "Domestic Wastewater" shall mean liquid and liquid-borne wastes normally discharged from premises occupied by humans as living quarters.

11. "Environmental Protection Agency (EPA)" shall mean the Federal Agency responsible for protecting human health and safeguarding the natural environment air, water, and land.

12. "Grab Sample". A sample that is taken from a waste stream on a one-time basis with no regard to the flow in the waste stream and over a period of less than fifteen minutes.

13. Non-conventional Pollutant" shall mean any pollutant that is not a conventional pollutant as defined herein.

14. "Industrial User" shall mean any user that discharges water carried wastes and wastewater to the District's sewerage facilities, and is identified in the Standard Industrial Classification Manual 1972, Officer of Management and Budget, as amended and supplemented under Divisions A, B, C, D, E and 1.

15. "Industrial Wastes" shall mean solid, liquid or gaseous substances discharged or flowing from an industrial, manufacturing or commercial premise resulting from manufacturing, processing, treating, recovery or development of natural or artificial resources of whatever nature.

16. "Industrial Wastewater" shall mean all water carried wastes and wastewater of the facility, excluding sanitary wastewater, and shall include all wastewater from any producing, manufacturing, processing, institutional, commercial, service, agricultural, or other operation. These may include wastes of human origin similar to domestic wastewater. Industrial wastewater is classified as regulated process wastewater, unregulated process wastewater, or dilute industrial wastewater.

17. "Industrial Wastewater Discharge Permit" shall mean written documentation, signed by the Director or his designee, authorizing discharge of industrial wastewater into the District sewerage system. Industrial Wastewater Discharge Permits shall state all conditions, requirements and limitations placed on the permittee by the district.

18. "Interference". The inhibition or disruption of the POTW treatments, processes or

operations, which contributes to a violation of any requirement of the treatment plant's Discharge Permit. The term includes prevention of sewage sludge use or disposal by the POTW in accordance with 405 of the Act (33 U.S.C. 1345) or any criteria, guidelines, or regulations developed pursuant to the Solid Waste Disposal Act (SWDA), the Clean Air Act, the Toxic Substances Control Act, or more stringent State criteria (including those contained in any State sludge management plan prepared pursuant to Title IV of SWDA) applicable to the method of disposal or use employed by the POTW.

19. "Local Limits" mean the limits developed by the POTW to implement the general and specific prohibitions listed in this Ordinance.

20. "Mass Emission Rate" shall mean the weight of material discharged to the sewer system during a given time interval. Unless otherwise specified, the mass emission rate shall mean pounds per day of a particular constituent or combination of constituents.

21. "National Categorical Pretreatment Standard or Pretreatment Standard". Any regulation containing pollutant discharge limits promulgated by the EPA in accordance with Section 307(b) and (c) of the Act (33 U.S.C. 1347) which applies to a specific category of Industrial Users.

22. "National Standard". Any regulation developed under the authority of Section 307(b) of the Act and 40 CFR, Section 403.5.

23. "New Source" means any source, the construction of which is commenced after the publication of proposed regulations prescribing a Section 307(c) (33 U.S.C. 1317) Categorical Pretreatment Standard which will be applicable to each source, if such standard is thereafter promulgated within 120 days of proposal in the Federal Register. Where the standard is promulgated later than 120 days after proposal, a new source means any source, the construction of which is commenced after the date of promulgation of the standard.

24. "Person" shall mean any person, firm, company, association, corporation, district, the State of California, the United States of America, or any department or agency thereof.

25. "pH" shall mean the negative of the logarithm of the Concentration in milligrams per liter, of the hydrogen ion in solution.

26. "Pollutant" shall mean any chemical, physical, biological, or radiological constituent or characteristic discharged or imparted to wastewater; standards limiting the quantity or quality of pollutants discharged in wastewater, or specifying management practices for such pollutants as condition of authorization to discharge, may be imposed by either the District or the regulatory bodies empowered to regulate the District.

27. "Publicly Owned Treatment Works (POTW)" shall mean the entire wastewater collection, transmission and treatment system operated in any part by the County of San Diego.

28. "Premise" shall mean any lot, piece or parcel of land, building or establishment.

29. "Pretreatment or Treatment" means the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater to a less harmful state prior to or in lieu of discharging or otherwise

introducing such pollutants into a POTW. The reduction or alteration can be obtained by physical, chemical or biological processes, or other process means, except as prohibited by 40 CFR Section 403.6(d).

30. "Pretreatment Requirements". Any substantive or procedural requirement related to pretreatment, other than a National Pretreatment Standard imposed on an Industrial User.

31. "Publicly Owned Treatment Works (POTW) means a wastewater treatment works which is owned by a state or municipality. This definition includes any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes and other conveyances used to convey wastewater to a POTW treatment plant.

32. "Sewer System" shall mean all construction and appurtenant equipment utilized in the collection, transportation, pumping, treatment and final disposal of wastewater within the District.

33. "Shall" is mandatory; "May" is permissive.

34. "Significant Industrial User" shall mean all categorical industrial users and any class II or class III user that:
    1. discharges an average of 25000 gpd or more of process wastewater to the POTW;
    2. contributes a process waste stream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or
    4. is designated a Significant Industrial User by the Control Authority on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement.

35. "Standard Industrial Classification (SIC)". A classification pursuant to the Standard Industrial Classification Manual issued by the Executive Office of the President, Office of Management and Budget, 1972. Or revisions thereof.

36. "Suspended Solids" shall mean solids that either float on the surface of, or are in suspension in water, sewage, or other liquids, and which are removable by laboratory filtering.

37. "Waste" shall mean sewage and any and all other waste substance, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation of whatever nature, including such wastes placed within containers of whatever nature, prior to and for the purpose of disposal.

38. "Wastewater Constituents and Characteristics" shall mean the individual chemical, physical, bacteriological and radiological parameters, including volume and flow rate and such other parameters that serve to define, classify or measure the quality and quantity of wastewater.

3.3 Abbreviations. The following abbreviations shall have the designated meanings:
"BOD" - Biochemical Oxygen Demand
"CFR" - Code of Federal Regulations

"COD" - Chemical Oxygen Demand
"EPA" - Environmental Protection Agency
"L" - Liter
"mg" - Milligrams
"mg/L" - Milligrams per Liter
"NPDES" - National Pollutant Discharge Elimination Systems
"POTW" - Publicly Owned Treatment Works
"SIC" - Standard Industrial Classification
"SWDA" - Solid Waste Disposal Act, 42 U.S.C. 6901, et seq.
"USC" - United States Code
"TSS" - Total Suspended solids

Article 4 - Industrial Wastewater Discharge Permit Issuance

4.1 Discharge of Commercial/Industrial Waste-Permit required.
Persons desiring to discharge industrial wastewater into the a District sewer system shall obtain an Industrial Wastewater Discharge Permit if said wastes contain constituents of a nature or quantity which meet either the City of San Diego or the County of San Diego requirements for regulation as described herein.

4.2 Procedure for the Processing of an Application.

4.2.1 All commercial/industrial users proposing to connect to any District sewerage system shall make a written application to the Department of Public Works.

4.2.2 Application Forms. Standardized application forms will be provided by the Director, or his designee, indicating thereon the information, which the applicant for a permit shall be required to furnish. At its own expense, the applicant may be required to provide (in addition to the information required to be furnished on the printed application form) such additional information, analyses, or data as deemed necessary by the Director, or his designee, to fully and adequately evaluate the use and discharge for which a permit is sought.

4.2.3 Director, or his designee, to evaluate the application. In evaluating an application, for a permit to discharge to the sewer, the Director or his designee shall consider the following factors:

(a) Whether the discharge of waste will cause damage to or be otherwise injurious or detrimental to the sewer systems;

(b) Whether the discharge of waste will cause an unwarranted increase in the cost of operation and maintenance of the POTW;

(c) Whether the discharge of waste will retard or inhibit the treatment of wastewater;

(d) Whether the discharge of waste will be detrimental to the quality of the receiving waters of the treated wastewater;

(e) Whether the waste discharge can be made acceptable by properly engineered pretreatment facilities including the case of septic system failure where the septic tank is retained for sludge management to reduce loading on sewer treatment facility.

(f) Whether the sewer system can properly and safely process the proposed industrial wastewater discharge; and,

(g) Any other matters deemed material in arriving at a determination of permittee's allowable discharge quantity and quality.

4.3 Permit Conditions.

4.3.1 Industrial Wastewater Discharge permittee shall be expressly subject to all provisions of this Ordinance and to all of the applicable regulations, use charges and fees established by the City and/or County of San Diego. Permits may contain the following:

(a) Limits on the average and maximum wastewater pollutant concentration or characteristics;

(b) The requirement for zero discharge of specified pollutants or process waste streams;

(c) The requirement that specific production or management practices or procedures be implemented for specific process waste streams;

(d) Limits on the average and maximum flow rate of discharge, restrictions limiting the time of discharge, or requirements for flow regulation and equalization;

(e) Requirements for installation and maintenance of inspection and sampling facilities;

(f) Specification for monitoring programs which may include sampling locations, frequency of sampling, number, types and standards for tests and reporting schedule;

(g) Compliance schedules;

(h) Requirements for submission of technical reports including but not limited to: Baseline Monitoring Reports, 90-Day Compliance Reports, periodic Self-Monitoring Reports, and certifications.

(i) Requirements for maintaining and retaining plant records relating to wastewater discharge as specified by the County, or it's designee, and affording access thereto;

(j) Requirements for notification of the County, or it's designee, of any new introduction of wastewater constituents or any substantial change in the volume or character of the wastewater constituents being introduced into the wastewater treatment system;

(k) Requirements for notification of slug discharges;

(l) Other conditions as deemed appropriate by the County, or it's designee to ensure compliance with this Ordinance.

4.4 Federal Categorical Standards, Existing Dischargers;

Within nine (9) months of the promulgation in the Federal Register, of a Federal Categorical Pretreatment Standard, the Industrial wastewater Discharge Permits, for users subject to such standard, shall be revised to require compliance with such standard within the time frame prescribed by such standard. Where a user, that is subject to a newly promulgated Federal Pretreatment Standard, has not previously submitted an application for an Industrial Wastewater Discharge Permit as required by this Ordinance, the user shall apply for an Industrial Wastewater Discharge Permit within 180 days after the promulgation of the applicable Federal Categorical Pretreatment Standard. In addition, the user with an existing Industrial Wastewater Discharge Permit shall submit to the Director, or his designee, within 180 days after the promulgation of an applicable Categorical Pretreatment Standard the following information:

4.4.1 Where known, the nature and concentration of any pollutants in the discharge which are limited by any County, State or Federal Pretreatment Standards, and a statement regarding whether or not the pretreatment standards are being met on a consistent basis and if not, whether additional Operation and Maintenance (O&M) and/or additional pretreatment is required for the user to meet applicable Pretreatment Standards.

If additional pretreatment and/or O&M will be required to meet the pretreatment standards, the user shall furnish the shortest schedule by which such additional pretreatment will be provided. The completion date in this schedule shall not be later than the compliance date established for the applicable pretreatment standard.

The following conditions shall apply to this schedule:

(1) The schedule shall contain increments of progress in the form of dates for the commencement and completion of major events leading into the construction and operation of additional treatment required for the user to meet the applicable pretreatment standards (e.g., hiring an engineer, completing Preliminary plans, completing final plans, executing contract for major components, commencing construction, completing construction, etc.).

(2) No increment referred to in paragraph (1) shall exceed nine (9) months.

(3) By each progress due date in the schedule, including the final date for compliance, the user shall submit a progress report to the Director, or his designee, including, at a minimum, whether or not it complied with the increment of progress to be met on such date and, if not, the date on which it expects to comply with this increment of progress, the reason for delay, and the steps being taken by the user to return the construction to the schedule established. In no event shall more than nine (9) months elapse between such progress reports.

4.5 Permit Duration. Permits shall be issued for a specified time as determined by the City or County of San Diego. A permit may be issued for a period less than a year or may be stated to expire on a specific date. The terms and conditions of the permit may be subject to modification by the Director, or his designee, during the terms of the permit as limitations or requirements as identified in Article 5 are modified or other just cause exists. The user shall be informed of any proposed changes in his permit at least 30 days prior to the effective date of change. Any changes or new conditions in the permit shall include a reasonable time schedule for compliance.

4.6 Permit Transfer. Industrial Wastewater Discharge Permits are issued to a specific user for a specific operation. A Wastewater Discharge Permit shall not be reassigned or transferred or sold to a new owner, new user, different premises, or a new changed operation.

4.7 Reporting Requirements for Permittee.

4.7.1 Compliance Date Report. Within 90 days following the date for final compliance with applicable pretreatment standards, or in the case of a new source, following commencement of the introduction of wastewater into the POTW, any user subject to pretreatment standards and requirements shall submit to the Director, or his designee, a report indicating the nature and concentration of all pollutants in the discharge from the regulated process which are limited by pretreatment standards and requirements and the average and maximum daily flow for those process units in the user facility which are limited by such pretreatment standards or requirements. The report shall state whether the applicable pretreatment standards or requirements are being met on a consistent basis, and if not, what additional O&M and/or pretreatment is necessary to bring the user into compliance with the applicable pretreatment standards or requirements. This statement shall be signed by an authorized representative of the industrial user and certified by a qualified professional. After initial report submittal, self-monitoring reports shall be submitted at least twice a year (usually June and December).

4.8 Tentative Nature of the Permit. If, after the granting of a permit, it shall develop, by reason of increased flow, change in the nature of industrial processes, or for any cause whatsoever that the industrial wastewater discharge by a permittee conflicts with any provisions of this Ordinance or any applicable State, Federal or Local law or ordinance the Director, or his designee may revoke or suspend the permit, or may require a re-evaluation of the permit, or may impose further conditions with respect thereto directed toward the elimination of such conflict. Any permittee shall immediately report to the Director, or his designee, any significant increase or decrease in flow or in the nature of the discharge and failure to do so shall be grounds for suspension or revocation of the permit.

Article 5 - Regulations.

5.1 General Discharge Prohibitions. No user shall contribute or cause to be contributed, directly or indirectly, any pollutant or wastewater which will interfere with the operation or performance of the POTW. These general prohibitions apply to all such users of a POTW whether or not the user is subject to National Categorical Pretreatment Standards or any other National, State or Local pretreatment standards or requirements. A user may not contribute the following substances to any POTW:

(a) Pollutants which create a fire or explosion hazard in the POTW, including, but not limited to, wastestreams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21.

(b) Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in Interference

(c) Pollutants which will cause corrosive structural damage to the POTW, but in no case Discharges with pH lower than 5.0 or greater than 12.5, unless the works is specifically designed to accommodate such Discharges

(d) Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems

(e) Any noxious or malodorous liquids, gases, or solids which either singly or by interaction with other wastes are sufficient to create a public nuisance or hazard to life or are sufficient to prevent entry into the sewers for maintenance and repair.

(f) Any substance which may cause the POTW effluent or any other product of the POTW such as residues, sludges, or scums, to be unsuitable for reclamation and reuse or to interfere with the reclamation process. In no case, shall a substance discharged to the POTW cause the POTW to be in noncompliance with sludge use or disposal criteria, guidelines or regulations developed under Section 405 of the Act; any criteria, guidelines, or regulations affecting sludge use or disposal developed pursuant to the Solid Haste Disposal Act, the Clean Air Act, the Toxic Substances Control Act, or State criteria applicable to the sludge management method being used.

(g) Any substance which will cause the POTW to violate its Discharge Permit or the receiving water quality standards.

(h) Any wastewater with objectionable color not removed in the treatment process, such as, but not limited to, dye wastes and vegetable tanning solutions.

(i) Heat in amounts which will inhibit biological activity in the POTW resulting in Interference, but in no case heat in such quantities that the temperature at the POTW Treatment Plant exceeds 40 deg.C (104 deg.F)

(j) Any pollutant, including oxygen-demanding pollutants (BOD, etc.) released in a Discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW.

(k) Any wastewater containing any radioactive wastes or isotopes of such half-life or concentration as may exceed limits established by the Director, or his designee, in compliance with applicable State or Federal regulations.

(l) Any wastewater which causes a hazard to human life or creates a public nuisance.

(m) Any trucked or hauled pollutants except at discharge points designated by the POTW.

(n) Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through.

(o) Any substance having the potential to pass-through or cause interference at the POTW by nature of quality or quantity as determined by the Director, or his designee.

5.2 No Dilution. No user shall ever increase the use of process water, or in any way attempt to dilute a discharge as a partial or complete substitute for adequate treatment to achieve compliance with the limitations contained in the Federal Categorical Pretreatment Standards, or with any other applicable pollutant-specific limitation developed by POTW, County or State.

5.3 Federal Categorical Pretreatment Standards. Upon the applicable compliance date of the Federal Categorical Pretreatment Standards for a particular industrial category, the Federal Standard, if more stringent than limitations developed and imposed under the authority of this Ordinance for sources in that category shall immediately supersede the limitations imposed under this Ordinance. The Director, or his designee, shall notify all affected users of the applicable standards, reporting requirements, and compliance dates, pursuant to 40 CFR, Part 403.12.

5.4 State Requirements. State requirements and limitations or discharges shall apply in any case where they are more stringent than Federal requirements and limitations or those in this ordinance.

5.5 County's Right of Revision. The County, or its designee, reserves the right to establish or revise local limits or requirements applicable to discharges to the sanitary sewer and disposal systems if deemed necessary to protect the health and safety of personnel or citizens, protect the collection system and POTW, or maintain compliance with applicable environmental regulations. In addition, the County of San Diego, or it's designee, reserves the right to require all businesses in Districts which ultimately discharge to the City of San Diego Metropolitan Wastewater Collection System, meet the requirements and conditions set forth in the City of San Diego Municipal Code which pertain to the sewer.

5.6 Pretreatment. Users shall provide necessary wastewater treatment as required to comply with this Ordinance and shall achieve compliance with all Federal Categorical Pretreatment Standards within the time limitations as specified by the Federal Pretreatment Regulations. Any facilities required to pretreat wastewater to a level acceptable to the County, or it's designee, shall be provided, operated, and maintained at the user's expense. Detailed plans showing the pretreatment facilities and operating procedures shall be submitted for review, and shall be acceptable to the County, or it's designee, before construction of the facility. The review of such plans and operating procedures will in no way relieve the user from the responsibility of modifying the facility as necessary to produce an effluent acceptable to the County, or it's designee under the provisions of this Ordinance, and the City of San Diego Municipal Code. Any subsequent changes in the pretreatment facilities or method of operation shall be reported and be acceptable to the County, or it's designee, prior to the user's initiation of the changes.

All records relating to compliance with pretreatment standards shall be made available to officials of the Director or his designee, upon request.

5.7 Inspection and Sampling. The County, or its designee may inspect the facilities of any user to ascertain whether the purpose of this Ordinance is being met and all requirements are being complied with. Persons or occupants of premises where wastewater is created or discharged shall allow the County, or it's designee ready access at all reasonable times to all parts of the premises for the purposes of inspection, sampling, records examination or as otherwise necessary in the performance of any of their duties. The County, or it's designee shall have the right to copy records, and to set up on the user's property such devices as are necessary to conduct sampling inspection, compliance monitoring and/or metering operations. Where a user has security measures in force which would require proper identification and clearance before entry into their premises, the user shall make necessary arrangements with their security guards so that upon presentation of suitable identification, personnel from the County or it's designee will be permitted to enter, without delay, for the purposes of performing their specific responsibilities.

5.8 Monitoring Facilities. Monitoring facilities shall be provided and operated at the user's own expense, to allow inspection, sampling, and flow measurement of the building sewer and/or internal drainage systems. The monitoring facility should normally be situated on the user's premises, but the County, or it's designee, may, when such a location would be impractical or cause undue hardship on the user, allow the facility to be constructed in the public street or sidewalk area and located so that it will not be obstructed by landscaping or parked vehicles.

There shall be ample room in or near such sampling manhole or facility to allow accurate sampling and preparation of samples for analysis. The facility, sampling, and measuring equipment shall be maintained at all times in a safe and proper operating condition at the expense of the user.

Whether constructed on public or private property, the sampling and monitoring facilities shall be provided in accordance with the City or County requirements and all applicable local construction standards and specifications. Construction shall be completed within 90 days following written notification by the County, or it's designee of the requirement for construction.

Article 6 - Grease Control for Commercial Food Preparation/Service Facilities

6.1 Pretreatment. Dischargers of greases and/or oils from commercial food preparation/service operations shall be required to install an approved type of grease pretreatment device in accordance with the Uniform Plumbing Code. The Director or his designee shall approve installation of the grease pretreatment equipment.

All required grease pretreatment shall be maintained in efficient operating condition by periodic removal of the accumulated grease. The discharging party shall be responsible for the proper removal and disposal by appropriate means of the material captured from grease pretreatment devices. No such collected grease shall be introduced into any drainage piping or public sewer.

6.2 Oil and Grease Discharge Limits. For the purpose of this ordinance, the discharge characteristics of organic oil and grease from any commercial food preparation/service facility shall have a discharge limit not exceeding 200 milligrams/liter.

6.3 Maintenance Reports. The Director, or his designee, may require the discharging party to keep records of grease pretreatment device maintenance and grease disposal by a licensed waste hauling company and to report on these maintenance activities to District. The Director, or his designee, may require the discharging party to provide results of periodic measurements of its discharge that is to include chemical analysis of oil and grease content. Discharging party shall allow the County or its representative ready access at all reasonable times to all parts of the premises for purposes of sampling and inspections.

Article 7 - Prohibitions On Discharge Of Water Softener Wastes.

7.1 The discharge of water softener brine wastes into District sewers shall be prohibited in accordance with the provisions of this Section. This Section is intended to apply to all Districts where the District's final treated wastewater effluent is discharged to inland disposal or water reclamation uses. For the purpose of this Section, a self-regenerating water softener unit shall be a water conditioning apparatus such as zeolite and resinous ion-exchange softeners or demineralizers or other like devices that require the periodic discharge of brine solutions in their operation.

(a) After May 5, 1978, no person shall install a self regulating water softener unit in a residential, commercial or industrial building or facility that is connected to a District sewer, unless the person demonstrates that water softener brine discharge facilities other than District sewers are available for receiving the water softener wastes. Such installations shall require approval by the Director, or his designee, and must conform to requirements of other regulatory authorities. Not withstanding the above, commercial and industrial facilities shall have an Industrial Waste Discharge Permit issued for such installation. As a prerequisite to issuance of such a permit, detailed construction plans showing the piping arrangement to be associated with such water softener unit shall be submitted to the Director, or his Designee, for approval. Such plans shall, among other things, clearly indicate that the possibility of any discharge of water softener brine into the District sewer system has been effectively precluded.

(b) All self-regenerating water softener units installed prior to the effective date of this Ordinance shall be disconnected from the District sewer within five years from May, 1978.

(c) Self-regenerating water softener units installed after the effective date of this Ordinance which are found discharging to a District sewer shall be removed on demand of the Director, or his designee. Should any such installation not be removed on demand of the Director, or his designee, the District may remove such installation at the expense of the customer or take action to disconnect the premise in accordance with Sections 70 and 71 of this Ordinance. (Added by Ord. 5131 N.S. Eff. 5 May 1978)

Article 8 - Enforcement of Ordinance:

8.1 Harmful Discharges. The County, or it's designee, may suspend the sewer system service and/or an Industrial Wastewater Discharge Permit when such suspension is necessary, in the opinion of the Director, or his designee in order to stop an actual or threatened discharge which presents or may present an imminent or substantial endangerment to the health or welfare of persons, or the environment.

Any person notified of a suspension of the wastewater treatment service and/or the wastewater discharge permit shall immediately stop or eliminate the contribution. In the event of a failure of the person to comply voluntarily with the suspension order, the County, or it's designee, shall take such steps as deemed necessary including immediate severance of the sewer connection, to prevent or minimize damage to the POTW system or endangerment to any individuals. The County, or its designee, shall reinstate the Industrial Wastewater Discharge Permit and/or the wastewater treatment service upon proof of the elimination of the non-complying discharge. A detailed written statement submitted by the user describing the causes of the harmful contribution and the measures taken to prevent any future occurrence shall be submitted to the County, or it's designee, within the appropriate time frame established by all applicable ordinances, codes and federal regulations.

8.2 Revocation of Permits. Any user who violates the following conditions is subject to having his permit revoked in accordance with the procedures of Article 7 of this Ordinance.

(a) Failure of a user to factually report the wastewater constituents and characteristics of his discharge.

(b) Failure of the user to report significant changes in operations, or wastewater constituents and characteristics.

(c) Refusal of reasonable access to the user's premises for the purpose of inspection or monitoring.

(d) Violation of conditions of the permit.

8.3 Notification of Violation. Whenever the County, or it's designee, finds that any user has violated or is violating this Ordinance, industrial wastewater discharge permit, or any prohibition, limitations, or requirements herein, the Director, or his designee, may serve upon such person a written notice stating the nature of the violation. The Director or his designee shall establish the appropriate time frame in which the permittee must correct any violation and return to compliance with the conditions set herein.

8.4 Civil Penalties. Civil Penalties - any user who is found to have willfully or negligently failed to comply with any provision of this Ordinance and permits issued hereunder may be fined at a rate determined appropriate by the Director, or his designee. The maximum rate shall not exceed twenty-five thousand dollars ($25,000.00) per violation per day. Each day on which a violation shall occur or continue shall be considered a separate and distinct offense. In addition to the penalties provided herein, the County may recover reasonable attorney's fees, court costs, court reporter's fees and other expenses of litigation by appropriate suit at law against the person found to have violated these rules, regulations orders and/or permits issued hereunder.

8.5 Criminal Penalties. The willful or negligent failure to comply with any provision of this Ordinance and permits issued hereunder may constitute a misdemeanor. Any person convicted of such a misdemeanor shall be punishable by a fine not exceeding one hundred thousand dollars ($100,000.00) or by imprisonment in the County Jail for a period of not more than six months or by such fine and imprisonment.

8.6 Falsifying Information. Any person who knowingly makes any false statements, representation or certification on any application, record, report, plan or other document files required pursuant to this Ordinance or Industrial Wastewater Discharge Permit, or who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required under this Ordinance shall, upon conviction, be punished by the provisions described in 7.4 and 7.5.

8.7 Violation: Responsibility for Loss or Damage. Any person violating any provision of this Ordinance shall be liable for all damage to the sewer system incurred as a result of such violation and for any increase in the cost of maintenance or repair resulting from such violation.

Article 9 - Accidental Discharges.

9.1 Each user shall provide protection from accidental discharge of prohibited materials or other substances regulated by this Ordinance. Facilities to prevent accidental discharge of prohibited materials shall be provided and maintained at the owner or user's own cost and expense. Detailed plans showing facilities and operation procedures to provide this protection shall be submitted to the County, or it's designee, for review and shall be approved by the County, or it's designee, before discharging wastewater into the sewer. Review and approval of such plans and operating procedures shall not relieve the industrial user from the responsibility to modify the user's facility as necessary to meet the requirements of this Ordinance, including but not limited to the City of San Diego Municipal Code, pertaining to wastewater discharge.

In the case of an accidental discharge, it is the responsibility of the user to immediately telephone and notify the Director, or his designee of the incident. The notification shall include location of discharge, type of waste, concentration and volume, and corrective actions.

9.2 Written Notice. Within five (5) days following an accidental discharge, the user shall submit to the Director, or his designee, a detailed written report describing the cause of the discharge and measures to be taken by the user to prevent similar future occurrences. Such notification shall not relieve the user of any expense, loss or damage.

Article 10 - Confidential Information.

10.1 Information and data on a user obtained from reports, questionnaires, permit applications, permits and monitoring programs and from inspections shall be available to the public or other governmental agency without restriction unless the user specifically requests and is able to demonstrate to the satisfaction of the County, or it's designee, that the release of such information would divulge information, processes or methods of production entitled to protection as trade secrets of the user. Effluent data, may not be afforded confidential status and shall be considered public information.

Article 11 - Legal Action.

11.1 If any person discharges sewage, industrial wastes or other wastes into the public wastewater disposal systems operated by the County of San Diego contrary to the provisions of this Ordinance, Federal or State pretreatment requirements, or any order of the County or it's designee, the County attorney may commence an action for appropriate legal and/or equitable relief in the appropriate court of the County of San Diego.

Article 12 - Severability

12.1 Severability of Provisions. If any section, subdivisions, sentence, clause or phrase of this ordinance is, for any reason, held to be invalid or unconstitutional, such invalidity or unconstitutionality shall nor affect the validity or constitutionality or the remaining portions of this ordinance; it being hereby expressly declared that this ordinance, and each section, subsection, sentence, clause and phrase hereof, would have been prepared, proposed, adopted, approved and ratified irrespective of the fact that any one or more other sections, subsections, sentences, clauses or phrases be declared invalid or unconstitutional.

Section V. Effective Date

This ordinance shall take effect and be in force thirty days after its passage, and before the expiration of fifteen days after its passage, a summary thereof shall be published once with the names of the members of this Board voting for and against it in the San Diego Commerce, a newspaper of general circulation published in the County of San Diego.

PASSED, APPROVED AND ADOPTED this 8th day of December, 1999.

APPENDIX B

CITY OF SAN DIEGO
METROPOLITAN WASTEWATER DEPARTMENT
PEAKING FACTOR CHART

CITY OF SAN DIEGO
METROPOLITAN WASTEWATER DEPARTMENT

PEAKING FACTOR FOR SEWER FLOWS
(Dry Weather)

Ratio of Peak to Average Flow*
Versus Tributary Population

Population	Ratio of Peak to Average Flow	Population	Ratio of Peak to Average Flow
200	4.00	4,800	2.01
500	3.00	5,000	2.00
800	2.75	5,200	1.99
900	2.60	5,500	1.97
1,000	2.50	6,000	1.95
1,100	2.47	6,200	1.94
1,200	2.45	6,400	1.93
1,300	2.43	6,900	1.91
1,400	2.40	7,300	1.90
1,500	2.38	7,500	1.89
1,600	2.36	8,100	1.87
1,700	2.34	8,400	1.86
1,750	2.33	9,100	1.84
1,800	2.32	9,600	1.83
1,850	2.31	10,000	1.82
1,900	2.30	11,500	1.80
2,000	2.29	13,000	1.78
2,150	2.27	14,500	1.76
2,225	2.25	15,000	1.75
2,300	2.24	16,000	1.74
2,375	2.23	16,700	1.73
2,425	2.22	17,400	1.72
2,500	2.21	18,000	1.71
2,600	2.20	18,900	1.70
2,625	2.19	19,800	1.69
2,675	2.18	21,500	1.68
2,775	2.17	22,600	1.67
2,850	2.16	25,000	1.65
3,000	2.14	26,500	1.64
3,100	2.13	28,000	1.63
3,200	2.12	32,000	1.61
3,500	2.10	36,000	1.59
3,600	2.09	38,000	1.58
3,700	2.08	42,000	1.57
3,800	2.07	49,000	1.55
3,900	2.06	54,000	1.54
4,000	2.05	60,000	1.53
4,200	2.04	70,000	1.52
4,400	2.03	90,000	1.51
4,600	2.02	100,000+	1.50

***Based on formula:** Peak Factor = $6.2945 \times (pop)^{-0.1342}$
(Holmes & Narver, 1960)

FIGURE 1-1

APPENDIX C

LANDSCAPE IRRIGATION DEMAND CALCULATIONS

COUNTY OF SAN DIEGO, DEPARTMENT OF PLANNING AND LAND USE

LANDSCAPE WATER REQUIREMENTS WORK SHEET: PART 1

(SITE TOTALS)

PROJECT NAME: Montecito Ranch COUNTY PROJECT# ____

PROJECT ADDRESS: 10/29 DRS/003 AB APN: ____

____ WATER DISTRICT: ____

SITE LANDSCAPE WATER USE TOTALS

The following is a summary of the total annual landscape water requirements for the site.

TOTAL GALLONS OF WATER REQUIRED: 92,395,158
(add gallons from each hydrozone)

TOTAL UNITS OF WATER REQUIRED: (1 unit = 748 gal.) 123,523
(total gallons / 748 = units of water)

ACRE FEET OF WATER REQUIRED: 283.4
(total gallons / 326,000 = acre ft.)

MAXIMUM APPLIED WATER ALLOWANCE CALCULATION

The following is a calculation of the Maximum Applied Landscape Water Allowance on site. This calculation is for comparison purposes only. It assumes the entire landscape area is planted in cool season turf with a crop coefficient (Kc) of 0.8, and utilizes a spray system with a Distribution Uniformity (DU) of 0.65 (65%).

TOTAL LANDSCAPE AREA (in square feet): ____

MAXIMUM APPLIED WATER ALLOWANCE IN INCHES. = $\frac{\text{ETo( ) X 0.8}}{0.65}$ = ( )

MAXIMUM USE GALLONS OF WATER = inches( ) X Landscape Area X (0.623) = ( )

MAXIMUM UNITS OF WATER = Total Gallons / 748 = ( )

MAXIMUM ACRE FEET OF WATER = Total Gallons / 326,000 = ( )

PERCENT SAVINGS = $\frac{\text{Max.Allow. - Actual Use}}{\text{Maximum Allowance}}$ = $\frac{(\quad)}{(\quad)}$ X 100 = ____%

Note: This calculation may be made in gallons, units, or acre feet.

COUNTY OF SAN DIEGO, DEPARTMENT OF PLANNING AND LAND USE

LANDSCAPE WATER REQUIREMENTS WORK SHEET: PART 2

(HYDROZONE CALCULATIONS)

HYDROZONE DATA:

Hydrozone Number: 1

Hydrozone Area (Sq.ft.): 459,726

Hydrozone Plant Type: ______
(turf, ornamental, native, etc)

Crop Coefficient (Kc): .80

Dist. Uniformity (DU): .65

Annual Refer. ET (ETo): 53.28

Seasonal ETo: ______
winter, spring, summer, fall
(circle one)

HYDROZONE WATER USE CALCULATION:

FORMULA:

$\frac{ETo \times Kc}{DU}$ = Annual water needs in inches for specified hydrozone

CALCULATION:

$\frac{ETo(53.28) \times Kc(.80)}{DU(.65)}$ = (66") inches of water per year for hydrozone.

GALLONS OF WATER FOR SPECIFIED HYDROZONE:

FORMULA:

Inches of water X Hydrozone area (in sq.ft.) X 0.623 (constant) = gallons of water per year for hydrozone.

CALCULATION:

Inches of water (66) X Hydrozone area (in sq.ft.) (459,726) X .623 = 18,901,013 (gallons) *

NOTES:

- Use one, "Work Sheet: Part 2", for each hydrozone.
- "Part 2", can be used for annual or seasonal calculations.
- Seasonal calculations are optional.

WMPWKSHT.002 revised 4/7/94

* INCLUDES 4.61 AC TURF
FROM SCHOOL SITE
ASSUMES 50% SITE IN TURF +/-

COUNTY OF SAN DIEGO, DEPARTMENT OF PLANNING AND LAND USE

LANDSCAPE WATER REQUIREMENTS WORK SHEET: PART 2

(HYDROZONE CALCULATIONS)

HYDROZONE DATA:

Hydrozone Number: 2

Hydrozone Area(Sq.ft.): 107,081

Hydrozone Plant Type: ____________
(turf, ornamental, native, etc)

ENTRY AREAS

Crop Coefficient (Kc): .70

Dist. Uniformity (DU): .05

Annual Refer. ET (ETo): 53.28

Seasonal ETo: ____________
winter, spring, summer, fall
(circle one)

HYDROZONE WATER USE CALCULATION:

FORMULA:

$\frac{\text{ETo X Kc}}{\text{DU}}$ = Annual water needs in inches for specified hydrozone

CALCULATION:

$\frac{\text{ETo(53.28) X Kc(.70)}}{\text{DU(.05)}}$ = (57") inches of water per year for hydrozone.

GALLONS OF WATER FOR SPECIFIED HYDROZONE:

FORMULA:

Inches of water X Hydrozone area (in sq.ft.) X 0.623 (constant) = gallons of water per year for hydrozone.

CALCULATION:

Inches of water (57) X Hydrozone area (in sq.ft.) (107,081 X .623 = 3,823,060 (gallons)

NOTES:

- Use one, "Work Sheet: Part 2", for each hydrozone.
- "Part 2", can be used for annual or seasonal calculations.
- Seasonal calculations are optional.

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COUNTY OF SAN DIEGO, DEPARTMENT OF PLANNING AND LAND USE

LANDSCAPE WATER REQUIREMENTS WORK SHEET: PART 2

(HYDROZONE CALCULATIONS)

HYDROZONE DATA:

Hydrozone Number: 3

Hydrozone Area(Sq.ft.): 383,768

Hydrozone Plant Type: ____________
(turf, ornamental, native, etc)

INTERNAL REFINED SLOPES

Crop Coefficient (Kc): .6

Dist. Uniformity (DU): .65

Annual Refer. ET (ETo): 53.28

Seasonal ETo: ____________
winter, spring, summer, fall
(circle one)

HYDROZONE WATER USE CALCULATION:

FORMULA:

$\frac{ETo \times Kc}{DU}$ = Annual water needs in inches for specified hydrozone

CALCULATION:

$\frac{ETo(53.28) \times Kc(.60)}{DU(.65)}$ = (49) inches of water per year for hydrozone.

GALLONS OF WATER FOR SPECIFIED HYDROZONE:

FORMULA:

Inches of water X Hydrozone area (in sq.ft.) X 0.623 (constant) = gallons of water per year for hydrozone.

CALCULATION:

Inches of water (49) X Hydrozone area (in sq.ft.) 383768 X .623 = 11,715,285 (gallons)

NOTES:

- Use one, "Work Sheet: Part 2", for each hydrozone.
- "Part 2", can be used for annual or seasonal calculations.
- Seasonal calculations are optional.

WMPWKSHT.002 revised 4/7/94

COUNTY OF SAN DIEGO, DEPARTMENT OF PLANNING AND LAND USE

LANDSCAPE WATER REQUIREMENTS WORK SHEET: PART 2

(HYDROZONE CALCULATIONS)

HYDROZONE DATA:

Hydrozone Number: 5

Hydrozone Area(Sq.ft.): 1,046,350

Hydrozone Plant Type:
(turf, ornamental, native, etc)
NATURAL (NATIVE) & NATURALIZANT PERIMETER SLOPES

Crop Coefficient (Kc): .35

Dist. Uniformity (DU): .65

Annual Refer. ET (ETo): 53.28

Seasonal ETo:
winter, spring, summer, fall
(circle one)

HYDROZONE WATER USE CALCULATION:

FORMULA:

$\frac{ETo \times Kc}{DU}$ = Annual water needs in inches for specified hydrozone

CALCULATION:

$\frac{ETo(53.28) \times Kc(.35)}{DU(.65)}$ = (29) inches of water per year for hydrozone.

GALLONS OF WATER FOR SPECIFIED HYDROZONE:

FORMULA:

Inches of water X Hydrozone area (in sq.ft.) X 0.623 (constant) = gallons of water per year for hydrozone.

CALCULATION:

Inches of water (29) X Hydrozone area (in sq.ft.) (1,046,350) X .623 = 29,744,605 (gallons)

NOTES:

- Use one, "Work Sheet: Part 2", for each hydrozone.
- "Part 2", can be used for annual or seasonal calculations.
- Seasonal calculations are optional.

WMPWKSHT.002 revised 4/7/94

APPENDIX D

TABLES

DETAILED WET WEATHER STORAGE CALCULATIONS

December 1977

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.00	0.32	0.49	0.00	0.00
2	0.00	0.32	0.49	0.00	0.00
3	0.00	0.32	0.49	0.00	0.00
4	0.00	0.32	0.49	0.00	0.00
5	0.00	0.32	0.49	0.00	0.00
6	0.00	0.32	0.49	0.00	0.00
7	0.00	0.32	0.49	0.00	0.00
8	0.00	0.32	0.49	0.00	0.00
9	0.00	0.32	0.49	0.00	0.00
10	0.00	0.32	0.49	0.00	0.00
11	0.00	0.32	0.49	0.00	0.00
12	0.00	0.32	0.49	0.00	0.00
13	0.00	0.32	0.49	0.00	0.00
14	0.00	0.32	0.49	0.00	0.00
15	0.00	0.32	0.49	0.00	0.00
16	0.00	0.32	0.49	0.00	0.00
17	0.00	0.32	0.49	0.00	0.00
18	0.56	0.32	0.49	0.32	0.32
19	0.00	0.32	0.49	0.32	0.64
20	0.00	0.32	0.49	0.32	0.96
21	0.00	0.32	0.49	0.32	1.28
22	0.02	0.32	0.49	0.32	1.60
23	0.12	0.32	0.49	0.32	1.92
24	0.02	0.32	0.49	0.32	2.24
25	0.29	0.32	0.49	0.32	2.56
26	1.01	0.32	0.49	0.32	2.88
27	0.17	0.32	0.49	0.32	3.20
28	0.24	0.32	0.49	0.32	3.52
29	0.43	0.32	0.49	0.32	3.84
30	0.05	0.32	0.49	0.32	4.16
31	0.01	0.32	0.49	0.32	4.48

January 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.00	0.32	0.20	0.32	4.80
2	0.00	0.32	0.20	0.32	5.12
3	0.02	0.32	0.20	0.32	5.44
4	0.08	0.32	0.20	0.32	5.76
5	1.05	0.32	0.20	0.32	6.08
6	0.76	0.32	0.20	0.32	6.40
7	0.10	0.32	0.20	0.32	6.72
8	0.00	0.32	0.20	0.32	7.04
9	0.13	0.32	0.20	0.32	7.36
10	5.33	0.32	0.20	0.32	7.68
11	0.68	0.32	0.20	0.32	8.00
12	0.00	0.32	0.20	0.32	8.32
13	0.00	0.32	0.20	0.32	8.64
14	0.05	0.32	0.20	0.32	8.96
15	2.21	0.32	0.20	0.32	9.28
16	0.01	0.32	0.20	0.32	9.60
17	1.51	0.32	0.20	0.32	9.92
18	0.06	0.32	0.20	0.32	10.24
19	0.29	0.32	0.20	0.32	10.56
20	0.02	0.32	0.20	0.32	10.88
21	0.00	0.32	0.20	0.32	11.20
22	0.00	0.32	0.20	0.32	11.52
23	0.00	0.32	0.20	0.32	11.84
24	0.00	0.32	0.20	0.12	11.96
25	0.00	0.32	0.20	0.12	12.08
26	0.00	0.32	0.20	0.12	12.20
27	0.00	0.32	0.20	0.12	12.32
28	0.00	0.32	0.20	0.12	12.44
29	0.00	0.32	0.20	0.12	12.56
30	0.21	0.32	0.20	0.32	12.88
31	0.55	0.32	0.20	0.32	13.20

February 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.00	0.32	0.72	0.32	13.52
2	0.00	0.32	0.72	0.32	13.84
3	0.00	0.32	0.72	0.32	14.16
4	0.00	0.32	0.72	-0.40	13.76
5	0.47	0.32	0.72	0.32	14.08
6	0.44	0.32	0.72	0.32	14.40
7	0.15	0.32	0.72	0.32	14.72
8	0.33	0.32	0.72	0.32	15.04
9	0.20	0.32	0.72	0.32	15.36
10	0.93	0.32	0.72	0.32	15.68
11	0.36	0.32	0.72	0.32	16.00
12	0.00	0.32	0.72	0.32	16.32
13	1.49	0.32	0.72	0.32	16.64
14	0.19	0.32	0.72	0.32	16.96
15	0.05	0.32	0.72	0.32	17.28
16	0.00	0.32	0.72	0.32	17.60
17	0.00	0.32	0.72	0.32	17.92
18	0.00	0.32	0.72	0.32	18.24
19	0.00	0.32	0.72	-0.40	17.84
20	0.00	0.32	0.72	-0.40	17.44
21	0.00	0.32	0.72	-0.40	17.04
22	0.00	0.32	0.72	-0.40	16.64
23	0.00	0.32	0.72	-0.40	16.24
24	0.00	0.32	0.72	-0.40	15.84
25	0.00	0.32	0.72	-0.40	15.44
26	0.00	0.32	0.72	-0.40	15.04
27	0.37	0.32	0.72	0.32	15.36
28	0.85	0.32	0.72	0.32	15.68

March 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	2.04	0.32	0.73	0.32	16.00
2	1.53	0.32	0.73	0.32	16.32
3	0.18	0.32	0.73	0.32	16.64
4	0.52	0.32	0.73	0.32	16.96
5	2.60	0.32	0.73	0.32	17.28
6	0.28	0.32	0.73	0.32	17.60
7	0.00	0.32	0.73	0.32	17.92
8	0.00	0.32	0.73	0.32	18.24
9	0.00	0.32	0.73	0.32	18.56
10	0.18	0.32	0.73	0.32	18.88
11	0.29	0.32	0.73	0.32	19.20
12	0.75	0.32	0.73	0.32	19.52
13	0.00	0.32	0.73	0.32	19.84
14	0.00	0.32	0.73	0.32	20.16
15	0.00	0.32	0.73	0.32	20.48
16	0.00	0.32	0.73	-0.41	20.07
17	0.00	0.32	0.73	-0.41	19.66
18	0.00	0.32	0.73	-0.41	19.25
19	0.00	0.32	0.73	-0.41	18.84
20	0.00	0.32	0.73	-0.41	18.43
21	0.07	0.32	0.73	0.32	18.75
22	0.12	0.32	0.73	0.32	19.07
23	0.04	0.32	0.73	0.32	19.39
24	0.00	0.32	0.73	0.32	19.71
25	0.00	0.32	0.73	0.32	20.03
26	0.00	0.32	0.73	0.32	20.35
27	0.00	0.32	0.73	-0.41	19.94
28	0.00	0.32	0.73	-0.41	19.53
29	0.01	0.32	0.73	0.32	19.85
30	0.25	0.32	0.73	0.32	20.17
31	0.67	0.32	0.73	0.32	20.49

April 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.14	0.32	0.59	0.32	20.81
2	0.02	0.32	0.59	0.32	21.13
3	0.00	0.32	0.59	0.32	21.45
4	0.00	0.32	0.59	0.32	21.77
5	0.05	0.32	0.59	0.32	22.09
6	0.00	0.32	0.59	0.32	22.41
7	0.39	0.32	0.59	0.32	22.73
8	0.26	0.32	0.59	0.32	23.05
9	0.16	0.32	0.59	0.32	23.37
10	0.00	0.32	0.59	0.32	23.69
11	0.00	0.32	0.59	0.32	24.01
12	0.00	0.32	0.59	0.32	24.33
13	0.00	0.32	0.59	-0.27	24.06
14	0.02	0.32	0.59	0.32	24.38
15	0.02	0.32	0.59	0.32	24.70
16	0.61	0.32	0.59	0.32	25.02
17	0.00	0.32	0.59	0.32	25.34
18	0.00	0.32	0.59	0.32	25.66
19	0.00	0.32	0.59	0.32	25.98
20	0.00	0.32	0.59	-0.27	25.71
21	0.01	0.32	0.59	-0.19	25.52
22	0.00	0.32	0.59	-0.27	25.25
23	0.00	0.32	0.59	-0.27	24.98
24	0.00	0.32	0.59	-0.27	24.71
25	0.01	0.32	0.59	-0.19	24.52
26	0.01	0.32	0.59	-0.19	24.33
27	0.00	0.32	0.59	-0.27	24.06
28	0.00	0.32	0.59	-0.27	23.79
29	0.00	0.32	0.59	-0.27	23.52
30	0.00	0.32	0.59	-0.27	23.25

May 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.26	0.32	0.84	0.32	23.57
2	0.08	0.32	0.84	0.32	23.89
3	0.00	0.32	0.84	0.32	24.21
4	0.00	0.32	0.84	0.32	24.53
5	0.00	0.32	0.84	0.32	24.85
6	0.00	0.32	0.84	-0.52	24.33
7	0.00	0.32	0.84	-0.52	23.81
8	0.00	0.32	0.84	-0.52	23.29
9	0.00	0.32	0.84	-0.52	22.77
10	0.00	0.32	0.84	-0.52	22.25
11	0.00	0.32	0.84	-0.52	21.73
12	0.00	0.32	0.84	-0.52	21.21
13	0.00	0.32	0.84	-0.52	20.69
14	0.00	0.32	0.84	-0.52	20.17
15	0.00	0.32	0.84	-0.52	19.65
16	0.00	0.32	0.84	-0.52	19.13
17	0.00	0.32	0.84	-0.52	18.61
18	0.00	0.32	0.84	-0.52	18.09
19	0.00	0.32	0.84	-0.52	17.57
20	0.00	0.32	0.84	-0.52	17.05
21	0.00	0.32	0.84	-0.52	16.53
22	0.00	0.32	0.84	-0.52	16.01
23	0.00	0.32	0.84	-0.52	15.49
24	0.00	0.32	0.84	-0.52	14.97
25	0.00	0.32	0.84	-0.52	14.45
26	0.00	0.32	0.84	-0.52	13.93
27	0.00	0.32	0.84	-0.52	13.41
28	0.00	0.32	0.84	-0.52	12.89
29	0.00	0.32	0.84	-0.52	12.37
30	0.00	0.32	0.84	-0.52	11.85
31	0.00	0.32	0.84	-0.52	11.33

June 1978

Date	Rainfall Inches, AF	Daily Effluent Production, AF	Daily Irrigation Need, AF	Effluent to Storage, AF	Total Effluent in Storage, AF
1	0.00	0.32	1.18	-0.86	10.47
2	0.00	0.32	1.18	-0.86	9.61
3	0.00	0.32	1.18	-0.86	8.75
4	0.00	0.32	1.18	-0.86	7.89
5	0.00	0.32	1.18	-0.86	7.03
6	0.00	0.32	1.18	-0.86	6.17
7	0.00	0.32	1.18	-0.86	5.31
8	0.00	0.32	1.18	-0.86	4.45
9	0.00	0.32	1.18	-0.86	3.59
10	0.00	0.32	1.18	-0.86	2.73
11	0.00	0.32	1.18	-0.86	1.87
12	0.00	0.32	1.18	-0.86	1.01
13	0.00	0.32	1.18	-0.15	0.15
14	0.00	0.32	1.18	0.00	0.00
15	0.00	0.32	1.18	0.00	0.00
16	0.00	0.32	1.18	0.00	0.00
17	0.00	0.32	1.18	0.00	0.00
18	0.00	0.32	1.18	0.00	0.00
19	0.00	0.32	1.18	0.00	0.00
20	0.00	0.32	1.18	0.00	0.00
21	0.00	0.32	1.18	0.00	0.00
22	0.00	0.32	1.18	0.00	0.00
23	0.00	0.32	1.18	0.00	0.00
24	0.00	0.32	1.18	0.00	0.00
25	0.00	0.32	1.18	0.00	0.00
26	0.00	0.32	1.18	0.00	0.00
27	0.00	0.32	1.18	0.00	0.00
28	0.00	0.32	1.18	0.00	0.00
29	0.00	0.32	1.18	0.00	0.00
30	0.00	0.32	1.18	0.00	0.00

APPENDIX E

POWER USE CALCULATIONS

APPENDIX E

POWER USE CALCULATIONS

Wastewater Treatment Plant Energy Use

(Data obtained from Energy Requirement for Small Wastewater Treatment Systems," Journal WPCF, Volume 53, Number 7, July 1981)

Plant Size:	105,670 gpd
Sludge Generation:	5,000 lbs/week

Energy Use (Article Page 1187)

Extended Aeration (100,000 gpd plant)	65,270 kWh/year
Delete Slow Sand Filters (pg. 1187)	- 1,135 kWh/year
Delete Sludge Drying Beds (pg. 1187)	- 121 kWh/year
Add Gravity Filters (pg. 1194)	+ 2,200 kWh/year
Subtotal	66,214 kWh/year

Adjust for actual plant size:

105,670 gpd / 100,000 gpd x 66,214 = 69,968 kWh/year

Add belt press (pg. 1175)

$$6{,}105 \text{ kWh/month} \times 12 \text{ months} \times \frac{5{,}000 \text{ lbs week}}{75{,}000 \text{ lbs week}}$$

= 4,884 kWh/year

Total plant use 74,852 kWh/year

Pump Station Energy Use

Easterly Station – 150 feet estimated total dynamic head

247 EDUs x 240 gpd/EDU = 59,280 gpd = 0.09 cfs

$$\frac{0.09 \text{ cfs} \times 150 \text{ feet} \times 62.4 \text{ lbs/ft}^3}{(550)\,(1.341 \text{ hp/kW})\,(0.50 \text{ efficiency})} \times 24 \text{ hrs/day} \times 365 \text{ days/yr} = 20{,}010 \text{ kWh/year}$$

Westerly Station – 155 feet estimated total dynamic head

170 EDUs x 240 gpd/EDU = 40,800 gpd = 0.06 cfs

$$\frac{0.06 \text{ cfs} \times 155 \text{ feet} \times 62.4 \text{ lbs/ft}^3}{(550)\,(1.341 \text{ hp/kW})\,(0.50 \text{ efficiency})} \times 24 \text{ hrs/day} \times 365 \text{ days/yr} = 13{,}785 \text{ kWh/year}$$

Total Energy Use

Treatment Plant	74,852 kWh/year
Easterly Pump Station	20,010 kWh/year
Westerly Pump Station	13,785 kWh/year
Total Energy Use	108,647 kWh/year

Use Total Energy Estimate of: 110,000 kWh/year

Energy requirement for small wastewater treatment systems

E. Joe Middlebrooks, Charlotte H. Middlebrooks, Sherwood C. Reed

Concern about energy use at wastewater treatment facilities has developed well after many of the plans were made for management of water pollution in the U. S. With changing standards and technology, information on energy requirements for 190 to 1.9×10^4 m^3/d (0.05 to 5 mgd) wastewater treatment systems is needed to avoid future errors and to provide information to assist in designing and planning. Several estimates have been made for large systems, usually in the range of 1.9 to 38×10^4 m^3/d (5 to 100 mgd), but because hundreds of small systems are being used, it is imperative that information be gathered on the energy requirements for wastewater treatment in small systems.

This paper summarizes the energy requirements for all viable alternatives presently available for the treatment of flow rates of 190 to 1.9×10^4 m^3/d (0.05 to 5 mgd) of wastewater. Various treatment combinations are compared, and the energy requirements for the most viably alternatives are presented in tabular form. The data can be combined to produce estimates of the energy requirements for all currently available unit operations and processes.

Other Studies

Only one comprehensive study of the energy requirements associated with wastewater treatment has been performed. Wesner *et al.*[1] presented a detailed analysis of energy requirements by unit operations and unit processes employed in wastewater treatment. The results of the Wesner *et al.*[1] study were presented in graphical form, with accompanying tables outlining the design considerations employed in developing the graphs. Energy requirements were presented in terms of the design flow rate of the treatment system in most cases, but when a wide choice of loading rates was applicable, the graphs were presented in terms of surface area or of the flow rate applied to the component of the system.

Culp[2] has presented an analysis of alternatives for future wastewater treatment at South Tahoe, Calif., that illustrates the increasing sensitivity of energy costs. When the original advanced wastewater treatment system was constructed in the late 1960s, energy was not costly and was not usually a significant factor in concept selection and design. Table 1 illustrates the energy required for alternatives compared with the original design.[2,3] It is anticipated that the final product from the flood irrigation land treatment alternative will be at least equal in quality to the original design effluent.

Energy requirements for four wastewater treatment systems, including sludge processing, that are capable of achieving secondary effluent quality and complete sludge treatment and disposal were presented by Wesner and Burris.[4] Estimated energy requirements were presented for trickling filter with anaerobic digestion, activated sludge (AS) with anaerobic digestion, AS with sludge incineration, and independent physical-chemical treatment with sludge incineration using 1.9- and 11.4- m^3/d (5- and 30-mgd) capacities. A comparison of energy requirements for the four systems treating 11.4 m^3/d (30 mgd) is shown in Figure 1.[4] The potential for solar energy as a method of heating the digester and control building was discussed. Heat recovery from wastewater effluents using heat pumps to heat digesters and buildings was considered.

Zarnett[5-7] has examined the energy requirements for water and wastewater treatment plants and has presented the requirements by unit operations employed, to make it convenient to assess any treatment system on the basis of total energy consumption. By combining various flow configurations, a system capable of producing a given effluent quality can be assembled and the energy requirements compared. Zarnett[5-7] cautions that the data were presented for comparative purposes and should not be used as absolute values.

Energy costs will become the predominant factor in the selection of small wastewater treatment systems

Energy requirements for various types of wastewater treatment plants were presented by Hagan and Roberts.[8] Land treatment systems were considered in addition to conventional secondary and tertiary treatment systems. Tradeoffs between pollutants removed from

Table 1—Energy requirement 2.8×10^4 m^3/d (7.5 mgd), Lake Tahoe Wastewater Treatment system.[3]

Alternative	Total energy[a] (electricity and fuel expressed as equivalent M kWh/yr)[b]
Original system complete secondary treatment, AWT system, effluent export to Indian Creek Reservoir	64 500
1978 alternatives	
Continue secondary, nitrification, effluent export to Indian Creek Reservoir	39 400
Continue secondary, nitrogen removal (ion exchange) effluent export to Indian Creek Reservoir	40 244
Continue secondary on-site, flood irrigation land treatment in Carson River Basin	25 000

[a] Does not include secondary energy requirements for chemical manufacture.
[b] 1 kWh = 3.6×10^6J.

wastewater and pollutants added to the environment by energy use were discussed. It was pointed out that decreasing returns are obtained as the level of treatment increases and that it is possible to add more contamination to the environment by increased energy consumption than is removed from the wastewater. Comparisons of energy requirements for a 38×10^4 m^3/d (100-mgd) capacity system employing conventional secondary, advanced, and land treatment systems were presented. The energy implications of wastewater reuse were considered, and it was shown that in many instances reuse of wastewater can conserve energy. The savings are related to the degree of treatment required before reuse. Table 2 is a summary of total energy requirements for various wastewater treatment systems assumed by Hagen and Roberts[8] for direct discharge of the wastewater, employed for various reuse purposes, and the energy requirements for alternative sources of fresh water. The assumptions include preapplication treatment requirements that are unnecessarily stringent for general irrigation reuse.

Garber *et al.*[9] compared biological and physical-chemical wastewater treatment processes in the Los Angeles, Calif., area. It was found that biological processes were more energy efficient and placed less stress on the overall environment. Treatment of the wastewater by physical-chemical methods required almost five times as much energy as activated sludge, including nitrification and phosphorus removal. Solids disposal by pumping 145 to 161 km (90 to 100 miles) to the desert to drying beds required 16 times as much energy as the present system of discharging screened digested solids 11 km (7 miles) out to sea. Chemical treatment of the sludge followed by mechanical dewatering and disposal at local landfills, required 35 times as much energy as the current sludge disposal system.

The general problems associated with small wastewater treatment plants, alternative treatment processes available to small plants, important design considerations, and an economic comparison of the alternatives available were presented by Benjes.[10] Table 3 presents the estimated annual energy required for alternative wastewater treatment processes for a range of design

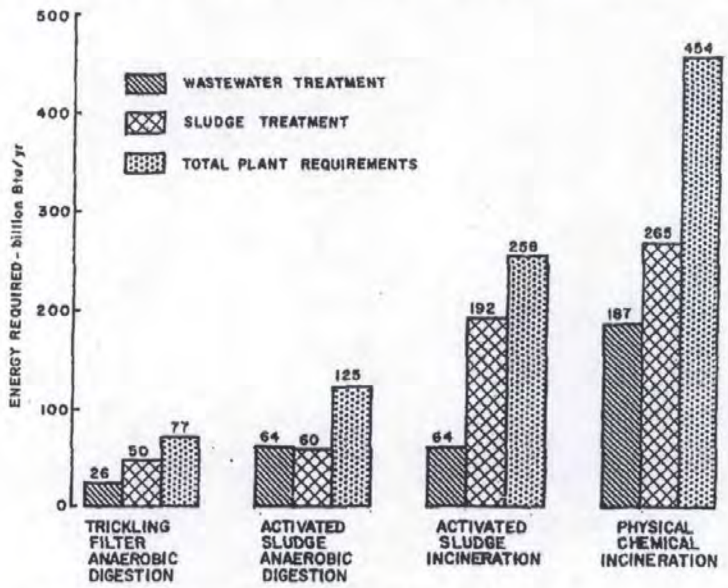


Figure 1—Energy requirement for (30 mgd) secondary treatment plants.

flows.[10] Tchobanoglous[11] conducted a similar analysis, and cost factors derived from his work are shown in Table 4.

Jacobs[12] discussed various ways to use energy more effectively at wastewater treatment plants. Use of different types of pumps and sludge dewatering equipment, plant modification, energy recovery from digester gas, and incineration of sludge was discussed. A comparison of energy requirements and cost for sludge dewatering equipment is shown in Table 5. Energy requirements and costs for biological treatment systems are presented in Table 6.

Table 2—Examples of systems to be considered in evaluating energy implications of wastewater reuse.[8]

	Total energy required for 38 $\times 10^4$ m^3/d (100 mgd) (kWh/d^a)
Treatment assumed for discharge	
Activated sludge (with clorination, sludge digestion, and landfill disposal)	93 000
Biological-chemical (activated sludge with alum treatment, nitrification/denitrification, sludge digestion, and landfill disposal)	235 000
Tertiary (activated sludge, coagulation/filtration, carbon adsorption, zeolite ion-exchange, recalcination)	1 137 000
Type of reuse	
Local irrigation, assume 30-m (100-ft) head	57 000
Distant irrigation, assume 460-m (1 500-ft) head	615 000
Industrial, assume 30-m (100-ft) head	57 000
Unrestricted, assume 150-m (500-ft) head	216 000
Treatment assumed prior to reuse	
For irrigation reuse	
Activated sludge	93 000
Biological-chemical	235 000
For industrial reuse	
Biological-chemical	235 000
Biological-chemical and desalting	695 000
Tertiary	1 137 000
Tertiary and desalting	1 597 000
For unrestricted reuse	
Tertiary	1 137 000
Tertiary and desalting	1 597 000
Alternative sources of fresh water	
Local supplies	57 000
Imported	938 000
Desalted sea water	6 661 000

^{a} 1 kWh = 3.6 $\times 10^6$ J.

Table 3—Estimated energy (electricity and fuel) for alternative treatment processes.[10]

Process^a	Energy (1 000 kWh/y)^b plant capacity (mgd)^c 0.1	0.5	1.0	2.0
Prefabricated extended aeration	139	—	—	—
Prefabricated contact stabilization	95	447	886	—
Custom design, extended aeration	197	857	1 901	—
Oxidation ditch	134	647	1 288	2 571
Activated sludge, anaerobic digestion	119	387	764	1 525
Activated sludge, nitrification, anaerobic digestion	251	650	922	2 576
Trickling filter, anaerobic digestion	31	126	246	485
RBC, anaerobic digestion	65	276	566	1 105
RBC, nitrification, anaerobic digestion	113	496	1 026	2 005

^{a} All with aerated grit chamber, chlorination, and sluge drying beds.
^{b} 1 kWh = 3.6 $\times 10^6$ J.
^{c} 1 mgd = 3 785 m^3/d.

Mills and Tchobanoglous[13] presented detailed methods for calculating energy consumption by the unit operations and processes used in wastewater treatment. Use of the equations and graphs presented in the paper is illustrated by examples using two alternative flow schemes. Detailed results are presented in tabular form and are easily compared between processes and systems.

Smith[14] estimated the electrical power consumption by most conventional and advanced processes used to treat municipal wastewater on a unit processes basis. Electrical power consumption for complete plants was estimated by adding the power consumption for the individual processes. Electrical power consumption by wastewater treatment systems was compared with consumption for other uses.

Estimates of recoverable energy in digester gases were made by Wesner and Clarke.[15] A discussion of the variation in gas production with the type of sludge was presented.

Table 4—Estimated total annual and units costs for alternative treatment processes with a design flow of 3 785 m^3/d (1.0 mgd).[11]

Process	Initial capital cost (dollars[a])	Annual Cost (dollars[b]) Capital[b]	Operation and Maintenance	Total	Unit cost (cents/1 000 gal[b,c])
Imhoff tank	380 000	41 720	15 550	57 270	15.7
Rotating biological disks	800 000	87 832	57 680	145 512	39.9
Trickling filter processes	900 000	98 811	58 480	157 291	43.1
Activated sludge processes					
With external digestion	1 000 000	109 790	74 410	184 200	50.5
With internal digestion	500 000	54 895	48 800	103 695	28.4
Stabilization pond processes	250 000	27 447	23 680	51 127	14.0
Land treatment processes					
Slow rate					
Basic system	340 000	37 328	41 540	28 859	21.6
With primary treatment	940 000	103 302	81 540	184 742	50.6
With activated sludge	1 240 000	136 139	115 950	252 089	69.1
With stabilization pond	590 000	64 775	65 220	129 996	35.6
Rapid infiltration					
Basic system	200 000	21 958	25 100	47 058	12.9
With primary treatment	800 000	87 832	65 100	152 932	41.9
With activated sludge	1 000 000	109 790	99 510	209 300	57.3
With stabilization ponds	450 000	49 405	48 780	98 185	26.9

[a] Based on an Engineering News Record Construction Cost index of 1900.
[b] Capital recovery factor = 0.10979 (15 years at 7%).
[c] 1 000 gal = 3.785 m^3.

Table 5—Energy comparison of sludge dewatering equipment.[12]

	kW demand (cost per month)	kWh usage (cost per month)	Monthly cost	Annual cost
Belt press filters	40.0 kW ($112.00)	6 105 kWh ($153.85)	$265.85	$3 190.20
Vacuum filter	75.5 kW ($210.00)	8 750 kWh ($220.50)	$430.50	$5 166.00
Centrifuges	108.0 kW ($299.60)	13 700 kWh ($313.05)	$612.65	$7 351.80

Notes—Based on dewatering 34 000 kg/wk (75 000 lb/wk) of waste activated sludge at 3% feed, and approximately 20% cake solids concentration. Costs based on varying rate schedule.

Table 6—Energy comparison of biological treatment systems.[12]

	Completely mixed AS[b]	Extended-aeration AS[a,b]	Carousel-extended-aeration AS[a,b]	Pure-oxygen AS[b]	Bio-disk
kW demand	550	540	525	525	425
Cost, $	1 070	1 053	1 053	1 020	800
kWh usage	230 000	236 000	218 000	216 000	188 000
Cost, $	3 423	3 498	3 282	3 247	2 701
Monthly cost, $	4 498	4 542	4 335	4 076	3 501
Annual cost, $	53 976	54 504	52 020	48 804	42 012

Notes—Comparison based on entire plant energy consumption. Includes consideration of differences in sludge quantity and characteristics. Costs based on varying rate schedule.
[a] Result in higher effluent quality.
[b] Activated sludge.

Table 7—Raw wastewater characteristics.[1]

Parameter	Concentration
BOD	210 mg/l
SS	230 mg/l
Phosphorus, as P	11 mg/l
Total Kjeldahl nitrogen, as N	30 mg/l
Nitrite plus nitrate	0 mg/l
Alkalinity, as $CaCO_3$	300 mg/l
pH	7.3

METHODS AND PROCEDURES

Equation development. The graphs presented by Wesner *et al.*[1] were converted to lines of best fit at the lower design flow rates $380–1.9 \times 10^4$ m^3/d (0.1 to 5.0 mgd) and used to calculate the energy requirements for small systems. Least-squares fits of the linear and curvilinear lines were employed. A power function was used to fit the linear lines on the log-log plots, and a polynomial equation was used to fit the curvilinear lines. The forms of the two functions are shown below.

$$\log Y = a + b(\log X) + c(\log X)^2 + d(\log X)^3$$

(polynomial function)

$$Y = aX^b \text{ (power function)}$$

Various combinations of the unit operations and processes were selected to form the most commonly used wastewater treatment systems. Energy requirements for each component of the system for various design flow rates were estimated using the equations of best fit. These results were tabulated for easy comparison between various types of treatment systems and can be obtained by referring to Middlebrooks and Middlebrooks[16]

Design parameters. Design parameters for all of the unit operations and processes and the energy equations for each operation or process are available in the report by Middlebrooks and Middlebrooks.[16] Additional detail can be obtained by referring to the report by Wesner *et al.*[1] The energy relationships for the conventional and advanced wastewater treatment processes reported by Wesner *et al.*[1] are unmodified, but it was necessary to modify the land application energy relationships to conform to accepted practice. The slow rate and overland flow application seasons were modified from 5 months per year to 250 days per year to reflect actual practice more realistically. Rapid infiltration application seasons extend over the entire year, and not 5 months per year as shown in the Wesner *et al.*[1] report.

Wastewater characteristics. The raw wastewater and sludge characteristics used to develop the energy relationships are presented in Tables 7 and 8, respectively.[1]

Energy recovery. The potential energy available in digester gas was estimated using a figure of (6.5×10^6 Btu/mil gal) of wastewater treated. This value is based on a mixture of primary and waste activated sludge, and the value will vary with the type of sludge and must be adjusted when better data are available. However, this value is satisfactory for estimating purposes and will yield a conservative estimate for net energy consumption.

The best available in digester gas can be converted to electricity, and a conversion factor of 12,028 kJ/kWh (11 400 Btu/kWh) can be used to estimate the elec-

Table 8—Sludge characteristics.[1]

Sludge type	Total solids (weight percent of sludge)	Sludge solids (lb/mil gal)[b]		Volatile solids (weight percent of total solids)	Sludge volume (gal/mil gal)
		Total solids	Volatile solids		
Primary	5	1 151	690	60	2 760
Primary + $FeCl_3$	2	2 510	1 176	47	16 500
Primary + low lime	5	4 979	2 243	45	11 940
Primary + high lime	7.5	9 807	4 370	45	15 680
Primary + WAS[a]	2	2 096	1 446	69	12 565
Primary + (WAS[a] + $FeCl_3$)	1.5	2 685	1 443	54	21 480
(Primary + $FeCl_3$) + WAS[a]	1.8	3 144	1 676	53	20 960
WAS[a]	1.0	945	756	80	11 330
WAS[a] + $FeCl_3$	1.0	1 535	776	50	18 400
Digested primary	8.0	806	345	43	1 210
Digested primary + WAS[a]	4.0	1 226	576	47	3 680
Digested primary + WAS[a] + FeCl	4.0	1 817	599	33	5 455
Tertiary alum	1.0	700	242	35	8 390
Tertiary high lime	4.5	3 139	3 219	40	21 690
Tertiary low lime	3.0	3 311	1 301	39	13 235

[a] WAS = Waste activated sludge.
[b] 1 lb/mil gal = 0.119 8 mg/l.

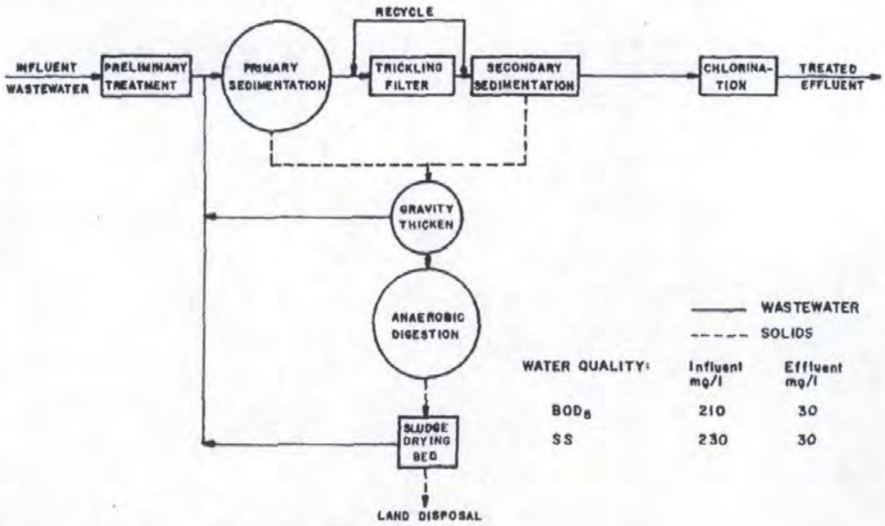


Figure 2—Trickling filter treatment with anaerobic digestion.

tricity generated. The conversion factor assumes an electrical generation efficiency of 30%. The gas utilization system also requires energy, and this must be considered when comparing systems.

Secondary energy. Secondary energy requirements are the amounts of energy needed to produce the consumable materials used in a wastewater treatment system. Disinfectants, coagulants, sludge conditioning chemicals, and regenerated activated carbon and ion exchange resins require energy in their production, and this energy must be considered when comparing the energy efficiency of various systems.

Methods of construction, materials of construction, seasonal variations, and other factors also influence the energy budget for a treatment system, but on a daily basis they influence the energy budget to a lesser degree than do primary factors such as direct energy consumption. Only direct energy consumption and secondary energy requirements are considered in this paper.

RESULTS AND DISCUSSION

Energy equations. The equations of the lines of best fit for the energy requirements of the unit operations and processes used in wastewater treatment based on the graphs reported by Wesner *et al.*[1] are presented in Middlebrooks and Middlebrooks.[15] The design conditions and assumptions used in developing the graphs are presented along with each equation. Details about the conditions imposed on the equations can be obtained from the Wesner *et al.*[1] report. Only the portions of the curves below a flow rate of 1.9×10^4 m^3/d (5 mgd)

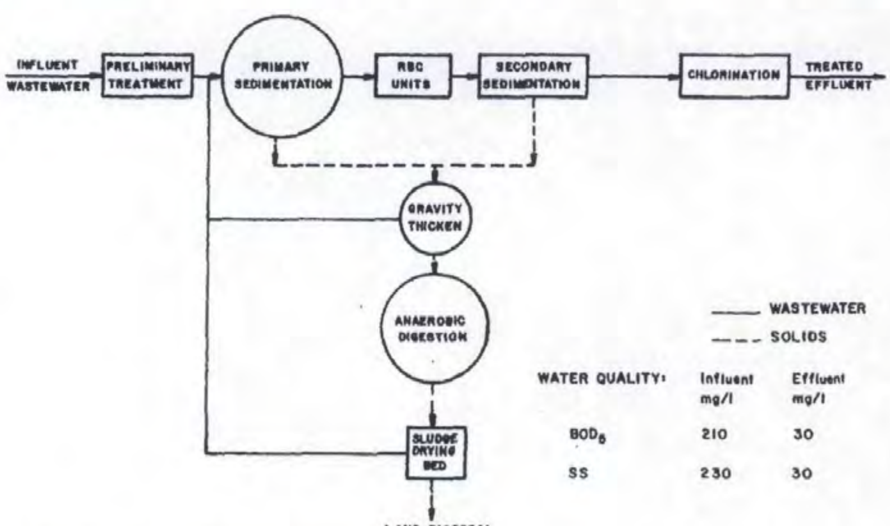


Figure 3—RBC treatment with anaerobic digestion.

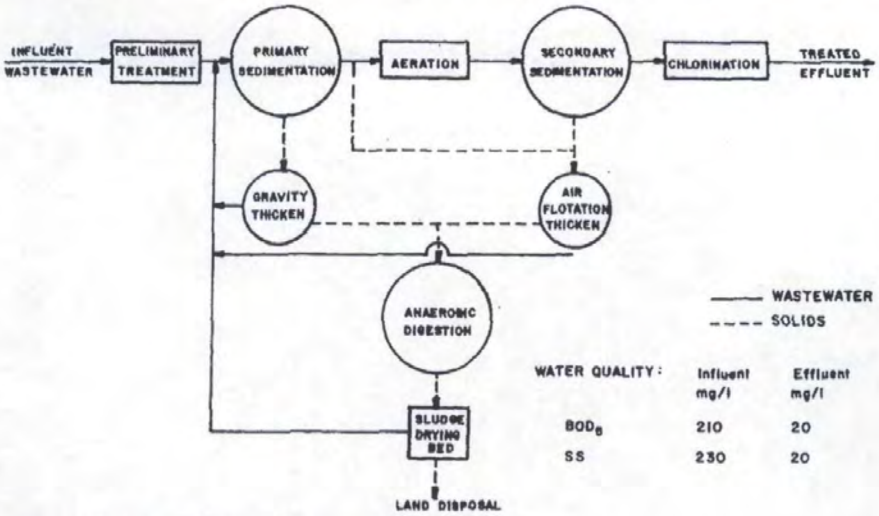


Figure 4—Activated sludge treatment with anaerobic digestion.

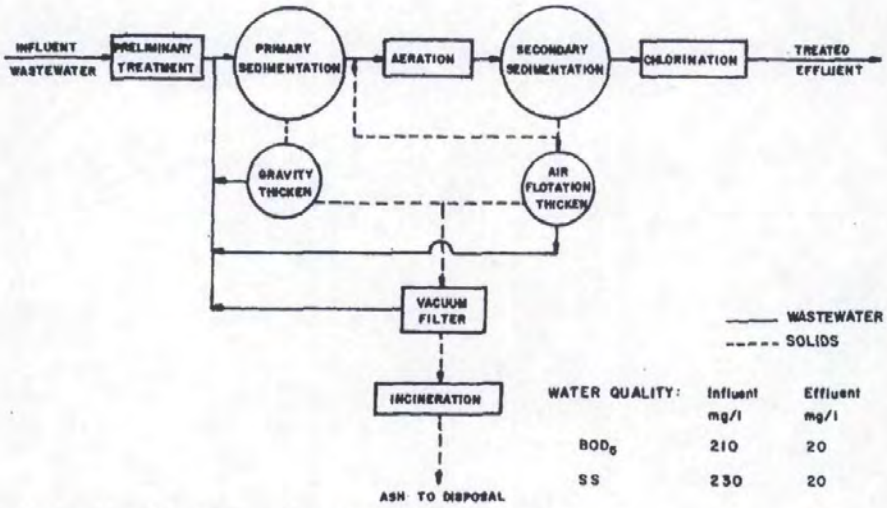


Figure 5—Activated sludge treatment with sludge incineration.

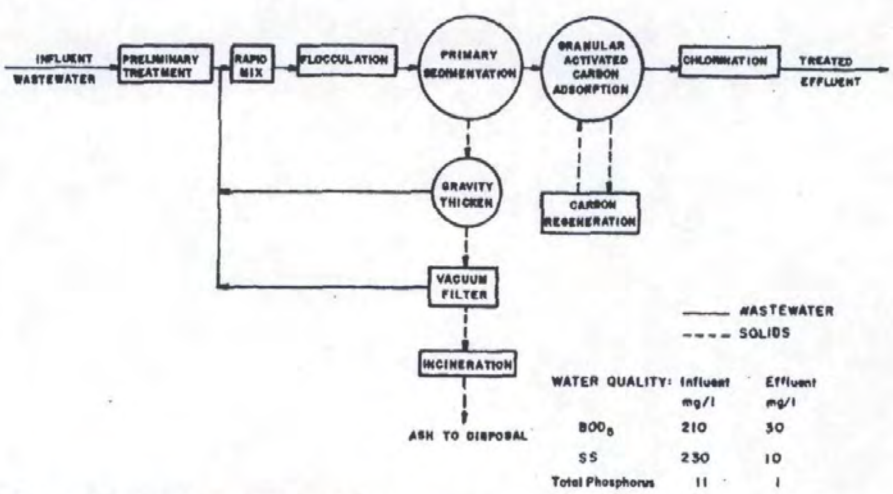
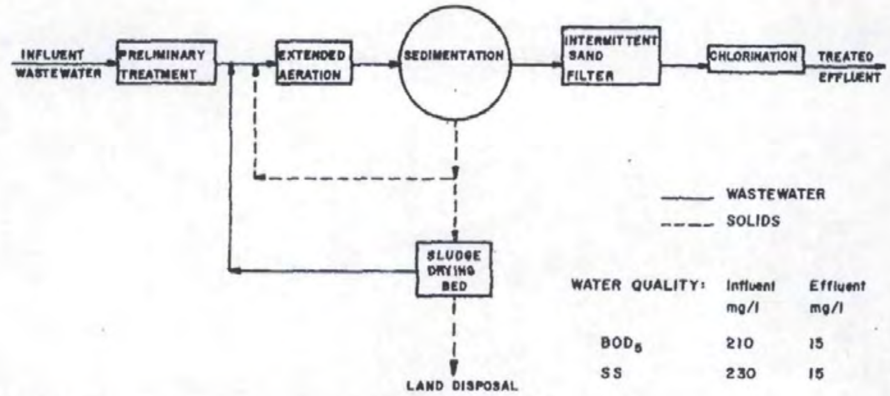
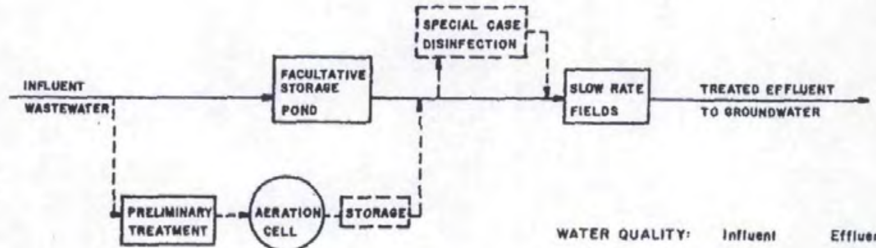


Figure 6—Physical-chemical advanced secondary treatment.



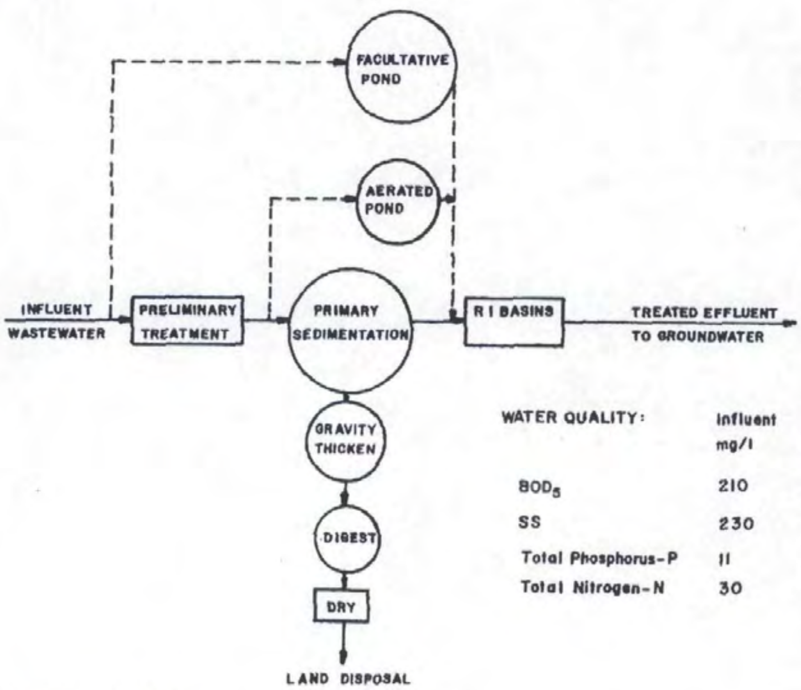
WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	15
SS	230	15

Figure 7—Extended aeration with intermittent sand filter.



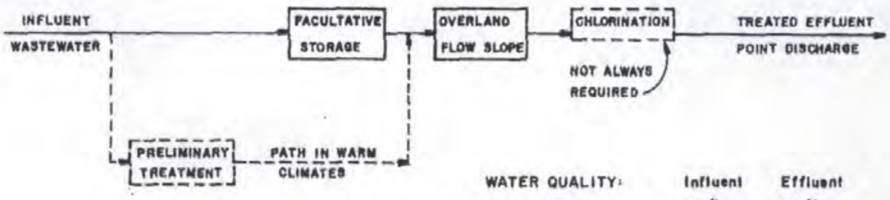
WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	1
SS	230	1
Total Phos-phorus-P	11	0.1
Total Nitro-gen-N	30	3

Figure 8—Slow-rate irrigation.



WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	5
SS	230	1
Total Phosphorus-P	11	2
Total Nitrogen-N	30	10

Figure 9—Rapid infiltration.



WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	5
SS	230	5
Total Phosphorus-P	11	5
Total Nitrogen-N	30	3

Figure 10—Overland flow.

were used to determine the line of best fit. This was done to obtain a better trend at the lower flow rates of interest, excluding the influence of the higher flow rates. All the equations for the linear lines have a correlation coefficient of 0.999 or better.

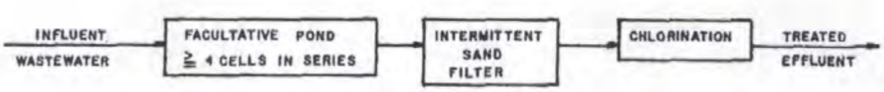
Treatment systems. Flow diagrams of the wastewater treatment systems commonly employed are shown in Figures 2 through 12. The flow diagrams for land application systems were selected utilizing the preapplication treatment guidelines shown in Table 9.[17] The biological and physical treatment systems shown in Figures 2, 3, 4, 7, 8, 9, 10, and 11 are most often employed in small systems; however, the activated sludge process with sludge incineration (Figure 5), physical-chemical treatment (Figure 6), and advanced treatment following secondary treatment (Figure 12) have been employed in special cases. These 11 systems can be modified by adding various processes in the treatment train to produce almost any quality effluent desired. Also, a very wide range of energy consumption can be experienced with these basic systems and their modifications. The raw wastewater characteristics and expected effluent quality from each of the systems are shown on the figures.

Energy consumption. Energy requirements for the components of the treatment systems shown in Figures 2 through 12 for various flow rates of wastewater treated by the systems are presented in Tables 10 through 21. The tables correspond to the figures; that is, Table 10 is a listing of the energy requirements for a trickling filter treatment system with anaerobic digestion (Figure 2).

Table 22 shows the energy requirements for components frequently appended to secondary treatment systems to produce better-quality effluent. By modifying the basic systems shown in Figures 2 through 12, it is possible to develop the energy requirements for almost any system applicable to the treatment of small flows of wastewater.

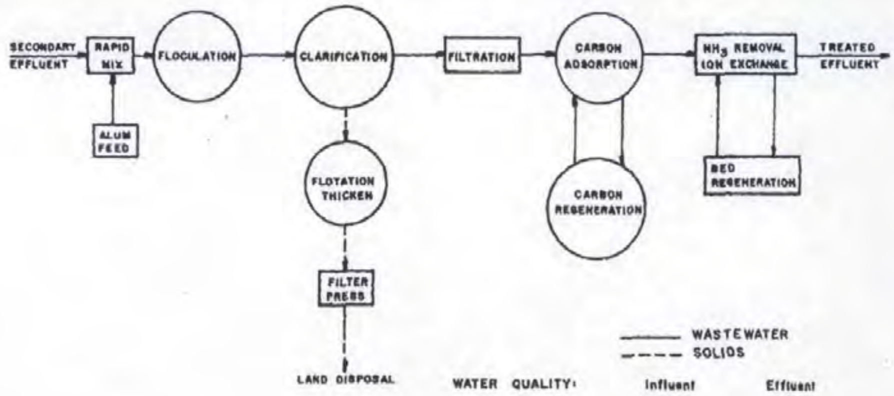
Carbon and ion exchange regeneration. Energy requirements for the regeneration of carbon and ion exchange materials for very-low-flow systems 190 to 380 m^3/d (0.05 to 0.1 mgd) are shown in Tables 14, 21, and 22 only for comparative purposes. In most cases activated carbon would be replaced rather than regenerated and the energy requirements would be reduced accordingly. The regeneration of ion exchange resins would probably be justified, but depending upon local conditions, it may be less expensive to replace ion exchange resins on a fixed schedule rather than to regenerate them.

Energy requirements for carbon regeneration represent less than 3% of the electricity and 94% of the fuel consumed in the components of an advanced treatment system following secondary treatment at a flow rate of 1.9×10^4 m^3/d (5 mgd). At a flow rate of 190 m^3/d (0.05 mgd), the energy requirements for carbon regeneration have been reduced to 2% of the electricity and 57% of the fuel. However, the inconvenience of operating additional equipment and the need for highly skilled operation would probably rule out the use of carbon regeneration at very small (<1 900 m^3/d [<0.5-mgd]) wastewater treatment systems.



WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	15
SS	230	15

Figure 11—Facultative lagoon with intermittent sand filter treatment.



WATER QUALITY:	Influent mg/l	Effluent mg/l
BOD_5	210	<10
SS	230	5
Total Phosphorus-P	11	<1
NH_3-N	15	<1

Figure 12—Advanced wastewater treatment.

Gas utilization. Although the energy required and produced by gas utilization is presented in the examples summarized in Tables 10, 11, and 12, gas utilization in small-flow systems, particularly at the lower flow rates of less than 1 900 m^3/d (0.5 mgd), may not be advisable. The increased operating expense caused by the need for a more skilled operator and more sophisticated equipment will likely offset any savings from gas utilization. However, this is a decision that must be made on an individual basis.

Table 9—Guidance for assessing level of preapplication treatment for land treatment systems.[17]

Slow-rate sytems (reference sources include Water Quality Criteria 1972, EPA-R3-73-003, Water Quality Criteria EPA 1976, and various state guidelines).

- Primary treatment is acceptable for isolated locations with restricted public access and when limited to crops not for direct human consumption.
- Biological treatment by lagoons or in-plant processes, plus control of fecal coliform count to less than 1 000 MPN/100 ml[a], is acceptable for controlled agricultural irrigation except for human food crops to be eaten raw.
- Biological treatment by lagoons or in-plant processes with additional BOD or SS control as needed for aesthetics plus disinfection to log mean of 200/100 ml (EPA fecal coliform criteria for bathing waters) is acceptable for application in public access areas such as parks and gold courses.

Rapid-infiltration systems

- Primary treatment is acceptable for isolated locations with restricted public access.
- Biological treatment by lagoons or in-plant processes is acceptable for urban locations with controlled public access.

Overland-flow systems

- Screening or comminution is acceptable for isolated sites with no public access.
- Screening or comminution plus aeration to control odors during storage or application is acceptable for urban locations with no public access.

[a] Most probable number of coliform bacteria per 100 ml of sample.

Effluent quality and energy requirements. Table 23 shows the expected effluent quality and the energy requirements for various combinations of the operations and processes shown in Figures 2 through 12 and Tables 10 through 22. Energy requirements and effluent quality are not directly related. Utilizing facultative lagoons and land application techniques, it is possible to obtain an excellent-quality effluent and expend small quantities of energy. Although one system may be more energy efficient, the selection of a wastewater treatment facility must be based upon a complete economic analysis. However, with rising energy costs, energy requirements are assuming a greater proportion of the annual cost of operating a wastewater treatment facility, and it is likely that energy costs will become the predominant factor in the selection of small-flow treatment systems. Operation and maintenance requirements, and consequently costs, are freqently kept to a minimum at small installations because of the limited resources and operator skills normally available. This favors the selection of systems employing units with low energy requirements. It is very likely that all future wastewater treatment systems at small installations in isolated areas will be designed employing low energy consuming units and simple operation and maintenance. The only exception to this will be in areas with limited space or construction materials, or where surplus energy is available.

The effluent quality expected with each of the treatment systems and the energy requirements shown in Table 23 are presented in the order of decreasing BOD_5 concentration in the effluent. The other parameters (SS, total P, and total N) do not necessarily decrease in the

Table 10—Energy requirements for components of a trickling filter system with anaerobic digestion in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Electricity (kWH/yr)	Fuel (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, nonaerated	260		305		450		530		690		780		
Primary sedimentation	2 530		3 190		5 420		6 820		9 970		11 990		Circular tanks
Trickling filter, rock media recirculation 2:1	3 670		7 200		31 950		61 300		172 200		278 300		
Secondary sedimentation	3 130		3 750		5 810		7 230		10 920		13 720		
Disinfection													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	16 795		26 805		93 390		170 720		466 080		752 540		
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Anaerobic digestion, high rate	1 220	62	2 435	124	12 180	632	24 354	1 270	73 060	3 860	121 760	6 460	Detection time = 20 days Mixing = 1/2 HP/1 000 cu ft
Drying beds	17	0.2	32	0.4	145	2	282	4	833	13	1 395	21	
Hauling, truck		13		26		128		256		767		1 278	
Landfill disposal		1.6		3.3		16		33		99		164	
Subtotal	1 272	77	2 536	154	12 641	778	25 246	1 563	75 623	4 739	125 885	7 923	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	18 266	225	29 585	335	106 489	1 098	196 612	1 996	542 931	5 484	880 151	8 911	
Digester gas utilization system	10 070	10	14 480	25	34 980	159	52 350	315	102 950	864	143 540	1 358	
Total with gas utilization	28 336	235	44 065	360	141 469	1 257	248 962	2 311	645 881	6 348	1 023 691	10 269	
Energy recovered, digester gas		119		237		1 187		2 373		7 119		11 865	

Notes—1 mgd = 3 785 m^3/d, 1 kWh = 3.6×10^6 J, 1 Btu = 1 055.056 J.

Table 11—Energy requirements for components of a RBC treatment system with anaerobic digestion located in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, nonaerated	260		305		450		530		690		780		
Primary sedimentation	2 530		3 190		5 420		6 820		9 970		11 990		
RBC units	3 650		7 300		36 500		73 000		219 000		365 000		Dense media
Secondary sedimentation	3 130		3 750		5 810		7 230		10 920		13 720		
Disinfection, Cl_2													
Primary energy	830		1,240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	16 775		26 905		97 940		182 420		512 880		839 240		
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Anaerobic digestion, high rate	1 220	62	2 435	124	12 180	632	24 354	1 270	73 060	3 860	121 760	6 460	
Drying beds	17	0.2	32	0.4	145	2	282	4	833	13	1 395	21	
Hauling, truck		13		26		128		256		767		1 278	
Landfill disposal		1.6		3.3		16		33		99		164	
Subtotal	1 272	77	2 536	154	12 641	778	25 246	1 563	75 623	4 739	125 885	7 923	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	18 246	225	29 685	335	11 039	1 098	208 312	1 996	589 731	5 484	966 851	8 911	
Digester gas utilization system	10 070	10	14 480	25	34 980	159	52 350	315	102 950	864	143 540	1 358	
Total with gas utilization	28 316	235	44 165	360	146 019	1 257	260 662	2 311	692 681	6 348	1 110 391	10 269	
Energy recovered, digester gas		119		237		1 187		2 373		7 119		11 865	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 BtU = 1 055.056 J

Table 12—Energy requirements for components of an activated slude system with anaerobic digestion in the intermountain area of the U. S.

Operation or process	0.05 mgd Electricity, (kWH/yr)	0.05 mgd Fuel, (millions of Btu/yr)	0.1 mgd Electricity, (kWH/yr)	0.1 mgd Fuel, (millions of Btu/yr)	0.5 mgd Electricity, (kWH/yr)	0.5 mgd Fuel, (millions of Btu/yr)	1.0 mgd Electricity, (kWH/yr)	1.0 mgd Fuel, (millions of Btu/yr)	3.0 mgd Electricity, (kWH/yr)	3.0 mgd Fuel, (millions of Btu/yr)	5.0 mgd Electricity, (kWH/yr)	5.0 mgd Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater Pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, aerated	10 610		11 400		12 290		13 270		17 800		22 670		
Primary sedimentation	2 530		3 190		5 420		6 820		9 970		11 990		Circular tanks
Aeration, mechanical	8 000		16 000		80 000		160 000		480 000		800 000		Complete mix
Secondary sedimentation	4 470		5 010		10 390		16 400		37 030		54 870		
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	32 815		47 960		157 860		291 330		817 100		1 337 280		
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Air flotation thickening	4 340		7 940		32 170		58 800		152 900		238 450		
Anaerobic digestion	1 220	52	2 435	104	12 180	518	24 354	1 040	70 060	3 110	121 760	5 180	Mixing = 1/2 HP/1 000 cu ft Detection time = 20 days
Drying beds	17	0.2	32	0.4	145	2	282	4	833	13	1 395	21	
Hauling, truck		12		24		120		240		720		1 200	
Landfill disposal		1.5		3.1	15.4		31		93		154		
Subtotal	5 612	66	10 476	132	44 811	655	84 046	1 315	225 523	3 936	364 335	6 555	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	38 626	214	58 680	313	203 129	975	376 022	1 748	1 043 851	4 681	1 703 341	7 543	
Digester gas utilization system	10 070	10	14 480	25	34 980	159	52 350	315	102 950	864	143 540	1 358	
Total with gas utilization	48 696	224	73 160	338	238 109	1 134	428 372	2 063	1 146 801	5 545	1 846 881	8 901	
Energy recovered, digester gas		119		237		1 187		2 373		7 119		11 865	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J

Table 13—Energy requirements for components of an activated sludge system with sludge incineration in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, aerated	10 610		11 400		12 290		13 270		17 800		22 670		
Primary sedimentation	2 530		3 190		5 420		6 820		9 970		11 990		Circular tanks
Aeration-mechanical	8 000		16 000		80 000		160 000		480 000		800 000		Complete mix
Secondary sedimentation	4 470		5 010		10 390		16 400		37 030		54 870		
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	32 815		47 960		157 860		291 330		817 100		1 337 280		
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Air flotation thickening	4 340		7 940		32 170		58 800		152 900		238 450		
Vacuum filter	13 198		13 320		18 950		25 190		45 460		63 020		
Incineration	2 250	145	3 870	287	12 350	1 440	20 630	2 880	46 520	8 630	67 900	14 390	
Ash hauling		11		22		109		217		651		1 085	20-mi round trip
Landfill disposal		1.4		2.8		14		28		84		140	
Subtotal	19 823	157	25 199	312	63 786	1 563	105 230	3 125	246 610	9 365	372 100	15 615	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	52 837	305	73 403	493	222 104	1 883	397 206	3 558	1 064 938	10 110	1 711 106	16 603	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6 × 10^6 J
1 Btu = 1 055.056 J
1 mi = 1.609 km
1 ft = 0.3048 m

Table 14—Energy requirements for components of a physical-chemical advanced secondary wastewater treatment system located in the intermountain area of the U. S.

Operation or process	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		Comments
	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, aerated	10 610		11 400		12 290		13 270		17 800		22 670		
Chemical clarification, $FeCl_3$													Dosgae = 200 mg/l
Primary energy	8 580		8 950		14 900		21 850		48 500		75 570		
Secondary energy	12 780		25 550		127 750		255 500		766 500		1 277 500		
Activated carbon													
Adsorption	3 100		6 200		31 000		62 000		186 000		310 000		Upflow expanded bed
Regeneration	1 900	200	3 800	400	19 000	2 000	38 000	4 000	114 000	12 000	190 000	20 000	
Secondary energy		19		38		192		383		1 150		1 916	
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	44 175	219	68 260	438	254 700	2 192	485 460	4 383	1 405 100	13 150	2 323 490	21 916	
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Vacuum filter	14 000		16 310		31 400		45 650		96 400		142 300		
Incineration	3 870	400	6 460	800	21 000	3 930	34 860	7 800	78 800	23 470	114 960	39 140	
Ash hauling		24		50		220		450		1 400		2 300	20-mi round trip
Landfill disposal		10		20		95		200		550		1 000	
Subtotal	17 905	434	22 839	870	52 716	4 245	81 120	8 450	176 930	25 420	259 990	42 440	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	62 279	801	91 343	1 489	307 874	6 757	567 226	13 266	1 583 258	39 315	2 585 206	65 344	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J
1 mi = 1.609 km
1 ft = 0.304 8 m

Table 15—Energy requirements for components of an extended aeration system with slow sand filter located in the intermountain area of the U. S.

Operation or process	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		Comments
	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, aerated	10 610	11 400		12 290		13 270		17 800		22 670			
Aeration	17 500		35 000		175 000		350 000		1 050 000		1 750 000		Mechanical
Secondary sedimentation	4 470		5 010		10 390		16 400		37 030		54 870		
Intermittent or slow sand filter	596	2.5	1 135	5	5 070	25	9 660	50	26 830	151	43 150	252	Total dynamic head = 5 ft; diesel powered truck and cleaning equipment. Hydraulic loading rate = 0.4 mgad* 12-hr operation of truck and cleaning equipment/acre 6 cleanings/year. Two gallons of fuel/hr. 1 gal = 140 000 Btu.
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	40 381	2.5	64 905	5	252 510	25	484 170	50	1 403 960	151	2 318 440	252	
Sludge treatment													
Drying beds	64	0.2	121	0.3	570	1.7	1 140	3.3	3 530	9.9	6 040	16.5	
Hauling, truck		12		24		120		240		720		1 200	
Landfill disposal		1.5		3.1		15.4		31		93		154	
Subtotal	64	14	121	27	570	137	1 140	274	3 530	823	6 040	1 371	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	40 644	164	65 270	213	253 538	484	485 956	757	1 408 718	1 719	2 326 206	2 611	

* Million gallons per acre per day

Notes: 1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J
1 gal = 3.785 l
1 ft = 0.3048 m

Table 16—Energy requirements for components of a slow-rate (irrigation) land treatment system located in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1.450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Aerated pond	13 000		26.000		130 000		260 000		780 000		1 300 000		
Subtotal	16 365		31 100		144 950		285 280		842 430		1 397 100		
Spray irrigation													
Solid set	8 970		17 570		83 720		164 000		476 050		781 350		
Center pivot	13 500		27 000		135 000		270 000		810 000		1 350 000		
Ridge and furrow, flooding	1 400	1	2 800	2	14 000	10	28 000	20	84 000	60	140 000	100	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system, aerated ponds													
Solid set	25 534	148	48 914	181	229 128	320	449 926	433	1 319 708	745	2 180 176	988	
Center pivot	30 064	148	58 344	181	280 408	320	555 926	433	1 653 658	745	2 748 826	988	
Ridge and furrow, flooding	17 964	149	34 144	183	159 408	330	313 926	453	927 658	805	1 538 826	1 088	
Total for treatment system, facultative ponds													
Solid set	10 369	148	20 094	181	94 378	320	184 046	433	531 178	745	869 776	988	
Center pivot	14 899	148	29 524	181	145 658	320	290 046	433	865 128	745	1 438 426	988	
Ridge and Furrow, flooding	2 799	149	5 324	183	24 658	330	48 046	453	139 128	805	228 426	1 088	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J
1 ft = 0.304 8 m

Table 17—Energy requirements for components of a primary wastewater treatment plant, followed by rapid infiltration land treatment systems, located in the intermountain area of the U. S.

Operation or process	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		Comments
	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Grit removal, nonaerated	260		305		450		530		690		780		
Primary sedimentation	2 530		3 190		5 420		6 820		9 970		11 990		Circular tank
Subtotal	6 155		8 595		20 820		32 630		73 090		109 870		
Rapid infiltration													
Flooding	141		287		1 480		3 000		9 200		15 490		
Sludge treatment													
Gravity thickening	35		69		316		610		1 730		2 730		
Anaerobic digestion, high rate	1 220	62	2 435	124	12 180	632	24 354	1 270	73 060	3 860	121 760	6 460	
Drying beds	17	0.2	32	0.4	145	2	282	4	833	13	1 395	21	
Hauling, truck		13		26		128		256		767		1 278	
Landfill disposal		1.6		3.3		16		33		99		164	
Subtotal	1 272	77	2 536	154	12 641	778	25 246	1 563	75 623	4 739	125 885	7 923	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	7 767	225	11 662	335	35 399	1 098	61 522	1 996	159 141	5 484	252 971	8 911	

Notes— 1 mgd = 3 785 m^3/d

1 kWh = 3.6×10^6 J

1 Btu = 1 055.056 J

1 ft = 0.304 8 m

Table 18—Energy requirements for components of a rapid-infiltration land treatment systems located in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar screen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Aerated pond	13 000		26 000		130 000		260 000		780 000		1 300 000		
Subtotal	16 365		31 100		144 950		285 280		842 430		1 397 100		
Rapid infiltration													
Flooding	141		287		1 480		3 000		9 200		15 490		
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system, aerated ponds													
Flooding	16 705	148	31 631	181	146 888	320	288 926	433	852 658	745	1 414 316	988	
Total for treatment system, facultative ponds													
Flooding	1 540	148	2 811	181	12 138	320	23 046	433	64 328	745	103 916	988	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6 × 10^6 J
1 Btu = 1 055.056 J
1 ft = 0.304 8 m

Table 19—Energy requirements for components of an overland-flow land treatment system located in the intermountain area of the U. S.

Operation or process	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		Comments
	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Preliminary treatment													
Bar streen	465		640		1 050		1 200		1 450		1 590		
Comminutor	1 700		2 180		3 700		4 680		7 080		8 810		
Aerated pond	13 000		26 000		130 000		260 000		780 000		1 300 000		
Subtotal	16 365		31 100		144 950		285 280		842 430		1 397 100		
Overland flow													
Flooding	460		920		4 600		9 200		27 600		46 000		
Solid set sprinklers	8 500		17 000		85 000		170 000		510 000		850 000		
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system, aerated ponds													
Flooding	20 864	148	39 524	181	184 818	320	364 686	433	1 081 128	745	1 795 476,	988	
Solid set sprinklers	28 904	148	55 604	181	265 218	320	525 486	433	1 563 528	745	2 599 476	988	
Total for treatment system, facultative ponds													
Flooding	5 699	148	10 704	181	50 068	320	98 806	433	292 598	745	485 076	988	
Solid set sprinklers	13 739	148	26 784	181	130 468	320	259 606	433	774 998	745	1 289 076	988	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J
1 ft = 0.304 8 m

same manner because most treatment facilities are designed to remove BOD_5 but in general there is a trend in overall improvement in effluent quality as one reads down the table. As shown in Table 23, there are many systems available to produce effluent that will satisfy EPA secondary or advanced effluent standards; however, the energy requirements of the various systems are varied and can differ by a factor of greater than 20 to produce the same quality effluent.

For purposes of comparison the total energy (electricity plus fuel: 3 412 Btu/kwh) for a typical 3 800 m^3/d (1-mgd) system has been extracted from Table 23 and listed in Table 24 in order of increasing energy requirements. It is quite apparent from Table 24 that increasing energy expenditures do not necessarily produce increasing water quality benefits. The four systems at the top of the list, requiring the least energy, produce effluents comparable to the bottom four, which require the most. Three of the top four are land treatment systems, and their adoption will depend on local site conditions. The facultative pond followed by intermittent sand filter and surface discharge to receiving waters is less constrained by local soil and groundwater conditions.

Conventional versus land treatment. A comparison of the energy requirements for a conventional wastewater treatment system consisting of a trickling filter system, followed by nitrogen removal, granular media filtration, and disinfection with a facultative pond, followed by overland flow and disinfection, is shown in Figure 13. This comparison is made because of the approximately equivalent quality effluents produced by the two systems (Table 23). The relationships in Figure 13 clearly show that there are significant electricity and fuel savings with the land application system. Similar comparisons for modifications of the two systems can be made by referring to Tables 18, 19, and 22 and selecting combinations to produce equivalent effluents.

Figure 14 shows a comparison of the energy requirements for an activated sludge plant producing a nitrified effluent, followed by granular media filtration and disinfection; for a facultative pond followed by rapid-infiltration land treatment; and for primary treatment followed by rapid-infiltration land treatment. The facultative pond system followed by rapid-infiltration land treatment is the most energy-efficient wastewater treatment system, but it is closely followed in energy efficiency by the primary treatment and rapid infiltration system. The energy requirements for both of the rapid infiltration land treatment alternatives are less than 15% of the energy required for the activated sludge system.

In Figure 15 energy requirements for slow-rate land application systems using ridge-and-furrow and center-pivot systems to distribute facultative pond effluent are compared with the energy requirements for an activated

Table 20—Energy requirements for components of a facultative lagoon–intermittent sand filter system located in the intermountain area of the U. S.

	0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Operation or process	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWh/yr)	Fuel, (millions of Btu/yr)	Comments
Wastewater treatment													
Raw wastewater pumping	1 200		2 280		10 200		19 400		53 900		86 700		Total dynamic head = 10 ft
Intermittent sand filter	596	2.5	1 135	5	5 070	25	9 660	50	26 830	151	43 150	252	
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	5 636		10 875		50 080		98 620		290 600		480 500		
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	5 835	150	10 919	186	50 538	345	99 266	483	291 828	896	482 226	1 240	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J
1 ft = 0.304 8 m

Table 21—Energy requirements for components of an advanced wastewater treatment system, processing secondary effluent, located in the intermountain area of the U. S.

Operation or process	0.05 mgd Electricity, (kWh/yr)	0.05 mgd Fuel, (millions of Btu/yr)	0.1 mgd Electricity, (kWh/yr)	0.1 mgd Fuel, (millions of Btu/yr)	0.5 mgd Electricity, (kWh/yr)	0.5 mgd Fuel, (millions of Btu/yr)	1.0 mgd Electricity, (kWh/yr)	1.0 mgd Fuel, (millions of Btu/yr)	3.0 mgd Electricity, (kWh/yr)	3.0 mgd Fuel, (millions of Btu/yr)	5.0 mgd Electricity, (kWh/yr)	5.0 mgd Fuel, (millions of Btu/yr)	Comments
Secondary effluent treatment													
Chemical clarification (alum)													
Primary energy	10 430		10 620		17 380		25 680		58 110		91 730		Dosage = 150 mg/l
Secondary energy	54 900		109 800		548 980		1 097 950		3 293 850		5 489 760		Zarnett, 1977 (5.29 kWh/kg)
Filtration	1 100		2 200		11 000		22 000		66 000		110 000		Gravity filters
Activated carbon													
Adsorption	3 100		6 200		31 000		62 000		186 000		310 000		Upflow expanded bed
Regeneration	1 900	200	3 800	400	19 000	2 000	38 000	4 000	114 000	12 000	190 000	20 000	
Ammonia-N removal													
Ion exchange	1 100		2 200		11 000		22 000		66 000		110 000		Gravity
Regeneration													
Primary energy	100		200		1 000		2 000		6 000		10 000		Regeneration with 2% NaCl
Secondary energy	456		913		4 560		9 130		27 380		45 630		
Disinfection, Cl_2													
Primary energy	830		1 240		4 700		9 330		29 170		49 520		Dosage = 10 mg/l
Secondary energy	3 010		6 020		30 110		60 230		180 700		301 130		
Subtotal	76 926	200	143 193	400	678 730	2 000	1 348 320	4 000	4 027 210	12 000	6 707 770	20 000	
Sludge treatment,													
Air flotation thickening	15 030		26 470		107 360		195 480		509 040		794 080		
Filter press	910		1 490		4 720		8 190		16 890		24 280		
Hauling, truck		3		5		25		50		150		250	
Landfill disposal		0.3		0.6		3		6		19		32	
Subtotal	15 940	3	27 960	6	112 080	28	203 670	56	525 930	169	818 360	282	
Other													
Building heating		148		181		320		433		745		988	
Building cooling	199		244		458		646		1 228		1 726		
Total for treatment system	93 065	351	171 397	587	791 268	2 348	1 552 636	4 489	4 554 368	12 914	7 527 856	21 270	

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J

Table 22—Energy requirements for components frequently appended to secondary wastewater treatment plants.

Operation or process	0.05 mgd Electricity, (kWH/yr)	0.05 mgd Fuel, (millions of Btu/yr)	0.1 mgd Electricity, (kWH/yr)	0.1 mgd Fuel, (millions of Btu/yr)	0.5 mgd Electricity, (kWH/yr)	0.5 mgd Fuel, (millions of Btu/yr)	1.0 mgd Electricity, (kWH/yr)	1.0 mgd Fuel, (millions of Btu/yr)	3.0 mgd Electricity, (kWH/yr)	3.0 mgd Fuel, (millions of Btu/yr)	5.0 mgd Electricity, (kWH/yr)	5.0 mgd Fuel, (millions of Btu/yr)	Comments
Filtration, gravity	1 100		2 200		11 000		22 000		66 000		110 000		
Filtration, pressure	1 500		3 030		15 390		31 000		94 030		157 510		
Intermittent sand filters and slow sand filters	596	2.5	1 135	5	5 070	25	9 660	50	26 830	151	43 150	252	
Microscreens													
25μ Screen	6 097		10 540		37 590		65 000		154 800		231 800		
35μ Screen	4 005		6 930		24 700		42 700		101 700		152 300		
Ammonia-N removal													
Ion exchange	1 100		2 200		11 000		22 000		66 000		110 000		Gravity
Regeneration													
Primary	100		200		1 000		2 000		6 000		10 000		Regeneration with 2% NaCl
Secondary	456		913		4 560		9 130		27 380		45 630		
Breakpoint chlorination + dechlorination	74 460		78 650		98 760		114 600		156 200		186 600		Dechlorination with sulfur dioxide
Nitrification, suspended growth	7 000		14 000		70 000		140 000		420 000		70 000		Mechanical aeration

Note—1 mgd = 3 785 m^3/d

sludge plant practicing nitrogen and phosphorus removal, granular media filtration of the effluent, and disinfection prior to discharge. The activated sludge and advanced treatment system and the facultative pond and slow-rate systems produce effluents approximately equivalent in quality. The ridge-and-furrow flooding technique of land treatment requires less than 5% of the energy required by the advanced treatment scheme. Utilizing a center pivot mechanism to distribute the facultative pond effluent increases the energy requirement by a factor of five compared with the ridge-and-furrow flooding technique, but the energy requirement for the center pivot system is less than 11% of the energy requirement for the advanced treatment system.

In an energy-conscious environment, the land application techniques of treating wastewater have a distinct advantage over the more conventional wastewater treatment systems. When land is available at a reasonable cost, the lower energy requirements for land application systems will probably result in a more cost-effective as well as more energy-effective system of wastewater treatment.

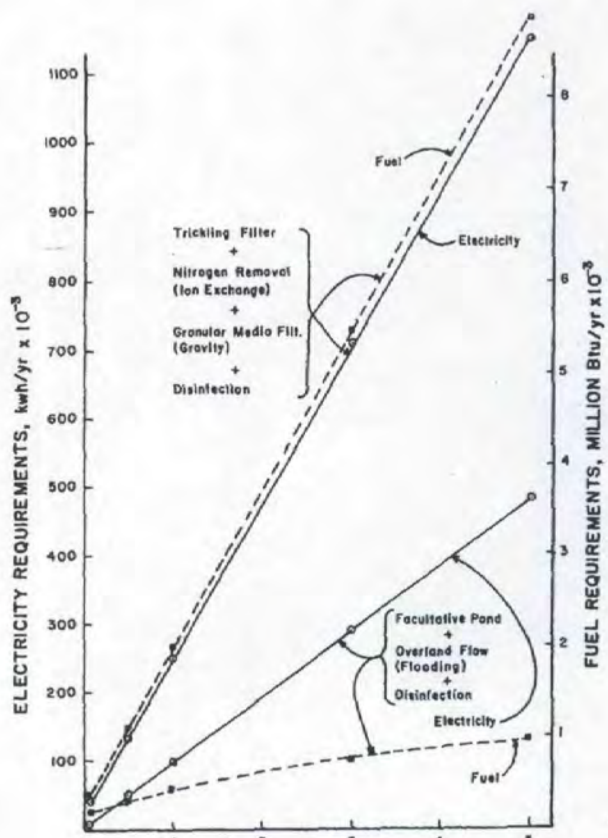


Figure 13—Comparison of energy requirements for trickling filter effluent treated for nitrogen and filtered, versus facultative pond effluent followed by overland flow treatment.

CONCLUSIONS

Based upon the results of the analyses presented in this paper, the following conclusions are made:

• With increasing energy costs, energy consumption is assuming a greater proportion of the annual cost of operating wastewater treatment facilities of all sizes, and because of this trend it is likely that energy costs will become the predominant factor in the selection of cost-effective small-flow wastewater treatment systems.

• Small-flow wastewater treatment systems are frequently designed to minimize operation and maintenance, and as energy costs increase, design engineers will tend to select low energy consuming systems.

• Low energy consuming wastewater treatment systems are generally easier to operate and maintain than energy-intensive systems, making the low energy consuming systems even more attractive because of the desire to minimize highly skilled operation at small facilities.

• Where suitable land and groundwater conditions exist, a facultative pond followed by rapid infiltration is the most energy-efficient system described in this paper.

• When surface discharge is necessary and impermeable soils exist, a facultative pond followed by overland flow is the second most energy-efficient system described in this paper.

• Facultative ponds, followed by slow or intermittent sand filters, are the fourth most energy-efficient systems discussed, and are not limited by local soil or groundwater conditions.

• Physical-chemical advanced secondary treatment systems utilize the most energy of the conventional methods of producing an effluent meeting the federal secondary effluent standard of 30 mg/l of BOD_5 and SS.

• Slow-rate land application systems following facultative ponds are more energy efficient than most forms of mechanical secondary treatment systems, while also providing the benefits of nutrient removal, recovery, and reuse.

• Advanced physical-chemical treatment following conventional secondary treatment consumes approximately 34 times as much electrical energy and 13 times as much fuel as slow-rate land treatment to produce an equivalent effluent.

• Land application wastewater treatment systems

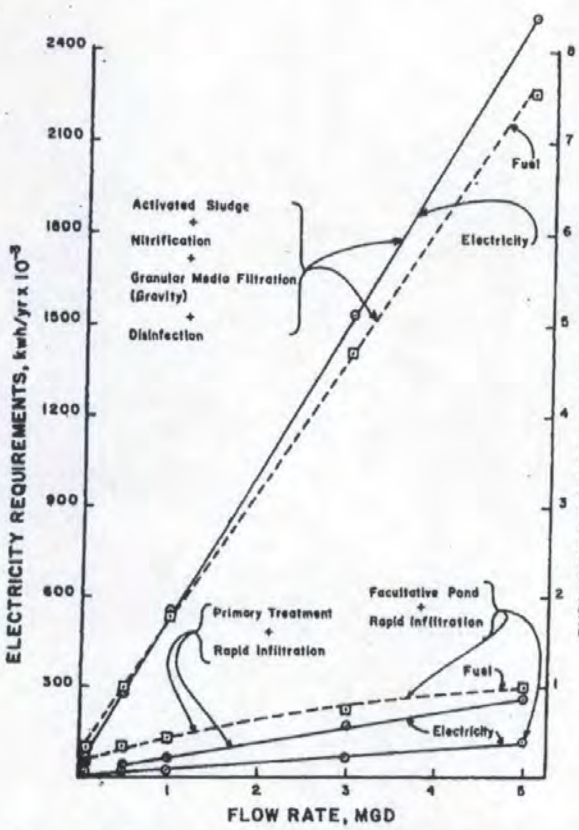


Figure 14—Comparison of energy requirements for activated sludge, nitrification, filtration, and disinfection, versus facultative pond effluent followed by rapid infiltration, and primary treatment followed by rapid infiltration.

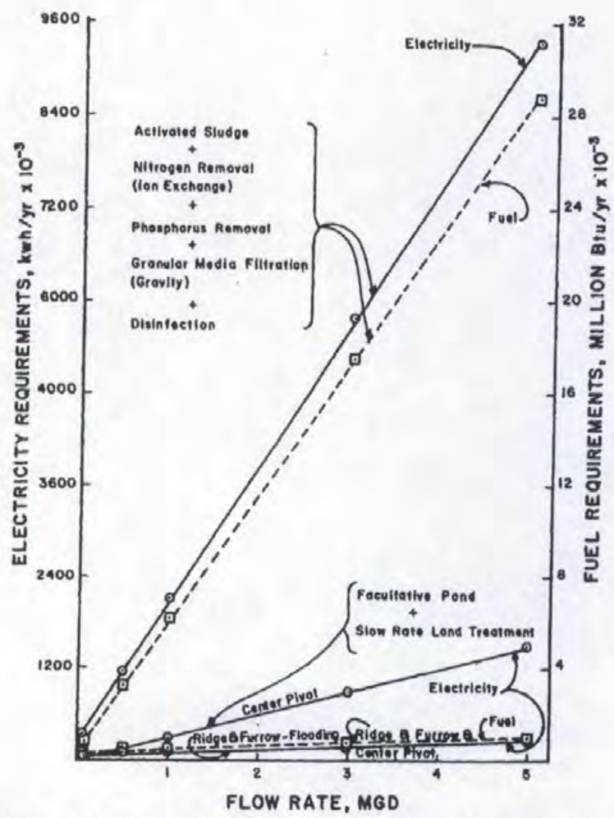


Figure 15—Comparison of energy requirements for secondary treatment followed by advanced treatment, versus facultative pond effluent followed by slow-rate land treatment.

Table 23—Expected effluent quality and total energy requirements for various sizes and types of wastewater

Treatment system	Effluent Quality (mg/l)			
	BOD_5	SS	Total Phosphorus as P	Total Nitrogen as N
Trickling filter with Anaerobic digestion	30	30	—	—
Rotating biological contactor with anaerobic digestion	30	30	—	—
Facultative pond + microscreens 23µ	30	30	—	15
Physical-chemical advanced secondary treatment	30	10	1	—
Activated sludge with anaerobic digestion	20	20	—	—
Activated sludge with sludge incineration	20	20	—	—
Extended aeration with sludge drying beds	20	20	—	—
Trickling filter + granular media gravity filtration	20	10	—	—
Trickling filter + N-removal (ion exchange) + Granular Media Filtration	20	10	—	5
Facultative pond + intermittent sand filter	15	15	—	10
Aerated pond + intermittent sand filler	15	15	—	20
Extended aeration + intermittents and filter	15	15	—	—
Activated sludge (A.D.) + Granular Media Gravity Filtration	15	10	—	—
Activated sludge + nitrification + Granular Media Gravity Filtration	15	10		
Overland flow-facultative pond flooding	5	5	5	3
Rapid infiltration-facultative pond flooding	5	1	2	10
Slow rate (irrigation)–Faculative pond-ridge and furrow flooding	1	1	0.1	3
Activated sludge + advanced treatment	<10	5	<1	<1

Notes—1 mgd = 3 785 m^3/d
1 kWh = 3.6×10^6 J
1 Btu = 1 055.056 J

following storage ponds (aerated or facultative), preliminary treatment (bar screens, comminutors, and grit removal), or primary treatment are by far the most energy-efficient systems capable of producing secondary effluent quality or better.

• This study did not consider the energy requirements for production of all materials consumed in the treatment process, but it is not believed that inclusion of such factors would significantly change the relative ranking of the systems discussed. Such inclusion would rather make the differences between simple biological processes and mechanical systems even more dramatic.

Table 24—Total annual energy for a typical 3 785 m^3/d (1-mgd) system (electrical plus fuel).

Treatment system	Effluent quality				Energy
	BOD	SS	P	N	
Rapid infiltration (facultative pond)	5	1	2	10	150
Slow rate, ridge and furrow (facultative pond)	1	1	0.1	3	181
Overland flow (facultative pond)	5	5	5	3	226
Facultative pond and intermediate filter	15	15	—	10	241
Facultative pond and microscreens	30	30	—	15	281
Aerated pond and intermediate filter	15	15	—	20	506
Extended aeration and sludge drying	20	20	—	—	683
Extended aeration and intermediate filter	15	15	—	—	708
Trickling filter and anaerobic digestion	30	30	—	—	783
RBC and anaerobic digestion	30	30	—	—	794
Trickling filter and gravity filtration	20	10	—	—	805
Trickling filter and N removal and filter	20	10	—	5	838
Activated sludge and anaerobic digestion	20	20	—	—	889
Activated sludge and anaerobic digestion and filter	15	10	—	—	911
Activated sludge and nitrification and filter	15	10	—	—	1 051
Activated sludge and sludge incineration	20	20	—	—	1 440
Activated sludge and advanced treatment	<10	5	<1	<1	3 809
Physical-chemical advanced secondary	30	10	1	—	4 464

Note—1 kWh = 3.6×10^6 J

treatment plants located in the intermountain area of the U. S.

Total Energy Requirements at Various Flow Rates												
0.05 mgd		0.1 mgd		0.5 mgd		1.0 mgd		3.0 mgd		5.0 mgd		
Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Electricity, (kWH/yr)	Fuel, (millions of Btu/yr)	Comments
18 300	225	29 600	355	106 500	1 100	196 600	2 000	542 900	5 490	880 200	8 910	See Figure 2 No energy recovery
18 200	225	29 700	335	111 000	1 100	208 300	2 000	589 700	5 490	966 900	8 910	See Figure 3 No energy recovery
11 300	148	20 300	181	83 100	320	154 600	433	419 800	745	670 900	988	
62 300	801	91 300	1 490	307 900	6 760	567 200	13 300	1 583 000	39 300	2 585 000	65 344	See Figure 6
38 600	214	58 700	313	203 100	975	376 000	1 760	1 044 000	4 680	1 703 000	7 540	See Figure 4 No energy recovery
52 800	305	73 400	493	222 100	1 880	397 200	3 560	1 065 000	10 000	1 711 000	16 600	Theoretically could recover enough heat to generate all needed electricity See Figure 5
40 000	161	64 100	208	248 500	457	476 300	707	1 382 000	1 570	2 283 000	2 360	See Figure 7
19 400	225	31 800	335	117 500	1 100	218 600	2 000	608 900	5 480	990 200	8 910	
21 000	225	32 900	335	134 000	1 100	251 700	2 000	708 300	5 480	1 155 800	8 910	
5 840	150	10 920	186	50 540	345	99 270	483	291 800	896	482 200	1.240	See Figure 11
20 800	151	39 500	186	184 800	345	364 500	483	1 079 100	896	1 790 900	1 240	
40 600	164	65 300	213	253 500	482	486 000	757	1 408 700	1 720	2 326 200	2 610	See Figure 7
39 700	214	60 900	313	214 100	975	398 000	1 750	1 109 900	4 680	1 813 300	7 540	
46 700	214	74 900	313	284 100	975	538 000	1 750	1 529 900	4 680	2 513 300	7 540	
5 700	148	10 700	181	50 070	320	98 810	433	292 600	745	485 080	988	See Figure 10
1 540	148	2 810	181	12 140	320	23 050	433	64 300	745	103 900	988	See Figure 9
2 800	149	5 300	183	24 700	330	48 050	453	139 100	805	228 400	1 090	See Figure 8
131 690	565	244 560	900	1 029 400	3 320	1 981 000	6 240	5 701 200	17 600	9 374 700	28 900	See Figure 12

ACKNOWLEDGMENTS

Authors. E. Joe Middlebrooks and Charlotte H. Middlebrooks are dean, College of Engineering, and computer specialist, College of Family Life, respectively, Utah State University, Logan. Sherwood C. Reed is research engineer, U. S. Army Cold Regions Research and Engineering Laboratory, Hanover, N. H.

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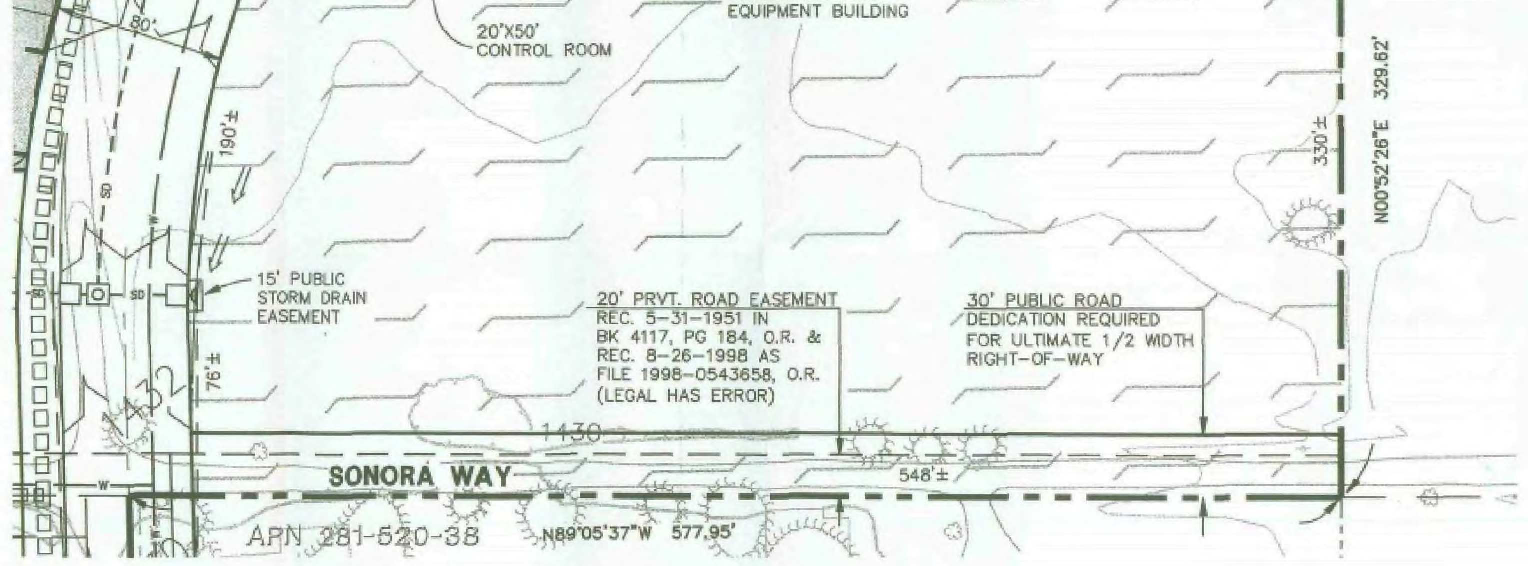
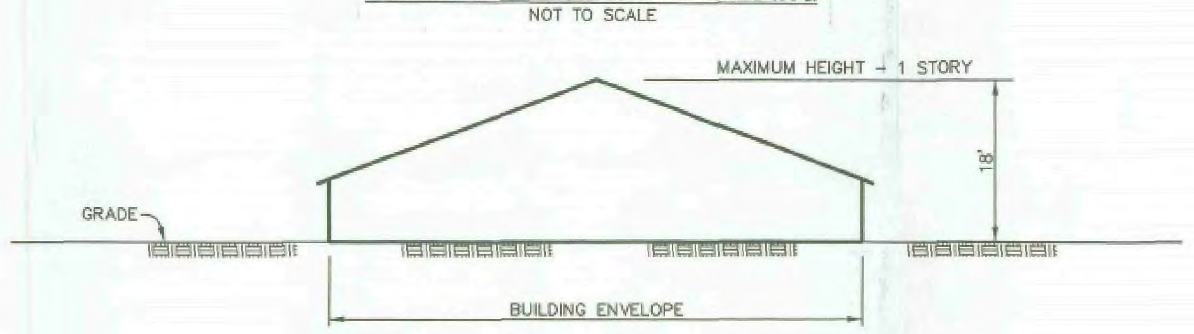
COUNTY OF SAN DIEGO
MAJOR USE PERMIT PLOT PLAN (P09-023)
MONTECITO RANCH WASTEWATER RECLAMATION FACILITY



SCALE: 1" = 60'

PROPOSED CONTROL BUILDING
NOT TO SCALE



EXISTING AND PROPOSED ZONING

SPECIFIC PLAN AREA (SPA)		EXISTING	PROPOSED
USE REGULATIONS		S-88	S-88
ANIMAL REGS		L	-
DEVELOPMENT REGULATIONS	DENSITY	-	-
	LOT SIZE	2.0 AC.	-
	BUILDING TYPE	C	C
	MAXIMUM FLOOR AREA	-	-
	FLOOR AREA RATIO	-	-
	HEIGHT	G	B
	LOT COVERAGE	-	-
	SETBACK	V	V
	OPEN SPACE	-	-
SPECIAL AREA REGULATIONS		POR S	B

NOTES

1. THE WASTEWATER RECLAMATION FACILITY WILL BE DEVELOPED TO COLLECT AND TREAT SEWAGE FROM ALL PORTIONS OF MONTECITO RANCH SPECIFIC PLAN AREA.
2. THE WASTEWATER RECLAMATION FACILITY WILL BE LOCATED IN THE SOUTHWEST PORTION OF LOT 435, IN THIS LOCATION IT IS RELATIVELY REMOTE FROM MOST RESIDENTIAL AREAS, AND IT IS ABLE TO TAKE ADVANTAGE OF EXISTING PHYSICAL FEATURES.
3. THE WASTEWATER RECLAMATION FACILITY CAN EMPLOY A PACKAGE TREATMENT PLANT WITH OPEN TANKAGE CONTAINING PUMPS AND PIPES THAT CAN BE BUILT AT OR ABOVE GRADE AND ACHIEVES TERTIARY QUALITY EFFLUENT. IT IS DESIGNED WITH 15' WATER DEPTH AND CAN TREAT UP TO 0.2 MGD. VOLUMES. MOREOVER, BECAUSE THERE IS NO LARGE EQUIPMENT, NOISE, VIBRATION, AND ODORS ARE MINIMIZED. THE FACILITY MUST BE DESIGNED TO MEET NOISE CRITERIA OF NO MORE THAN 55 DECIBELS AT THE PROPERTY LINE.
4. THERE WILL BE BERMING AND LANDSCAPING FOR VISUAL SCREENING.
5. THE SITE REQUIRED FOR THE PROPOSED WASTEWATER RECLAMATION FACILITY INCLUDES THE FOLLOWING ELEMENTS:
   A. 120'X120' AREA (24,000SF) WITH A 20'X50' BUILDING WHICH HOUSES THE CONTROL ROOM, ELECTRICAL EQUIPMENT, AIR BLOWERS, AND A SMALL LAB.
   B. EFFLUENT STORAGE AREA OF 25'X30.
   C. PROCESS AREA OF 20'X30'.
   D. DEWATERING AND EQUIPMENT BUILDING 40'X40'.
6. THE WASTEWATER RECLAMATION FACILITY WILL BE OWNED AND OPERATED BY A PUBLIC AGENCY.

OWNER/SUBDIVIDER

MONTECITO RANCH, LLC
A CALIFORNIA LIMITED LIABILITY COMPANY
402 WEST BROADWAY, SUITE 1320
SAN DIEGO, CA 92101-3542
TELEPHONE (619) 696-7355

LEGAL DESCRIPTION:

OF PORTIONS OF THE TOWN OF RAMONA, MAP NO. 644: PORTIONS OF RANCHO SANTA MARIA MAP NO. 863: PORTIONS OF WEEK END VILLAS, MAP NO. 1457: AND LOT 1, SECTION 8, TOWNSHIP 13 SOUTH, RANGE 1 EAST, SAN BERNARDINO MERIDIAN, IN THE COUNTY OF SAN DIEGO, STATE OF CALIFORNIA. (NOTE: THOSE PORTIONS OF MAP NO. 863 SHOWN HEREON ARE PORTIONS OF SECTIONS 4, 5, 7, 8, 9 AND 17, TOWNSHIP 13 SOUTH, RANGE 1 EAST, SAN BERNARDINO MERIDIAN, ACCORDING TO THE EXTENSION OF THE U.S. GOVERNMENT SYSTEM OF SURVEYS OVER SAID RANCHO SANTA MARIA REPUTED TO HAVE BEEN MADE BY O. N. SANFORD IN MAY, 1884.)

ENGINEER OF WORK

STEVENS CRESTO ENGINEERING, INC.
9665 CHESAPEAKE DRIVE, SUITE 320
SAN DIEGO, CA 92123
PHONE: (858) 694-5660
FAX: (858) 694-5661

ASSESSOR'S PARCEL NUMBERS & TAX RATE AREA TABLE

PARCEL NUMBER	TAX RATE AREA
280-010-09	

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NO.	REVISION	PREPARED BY	DATE

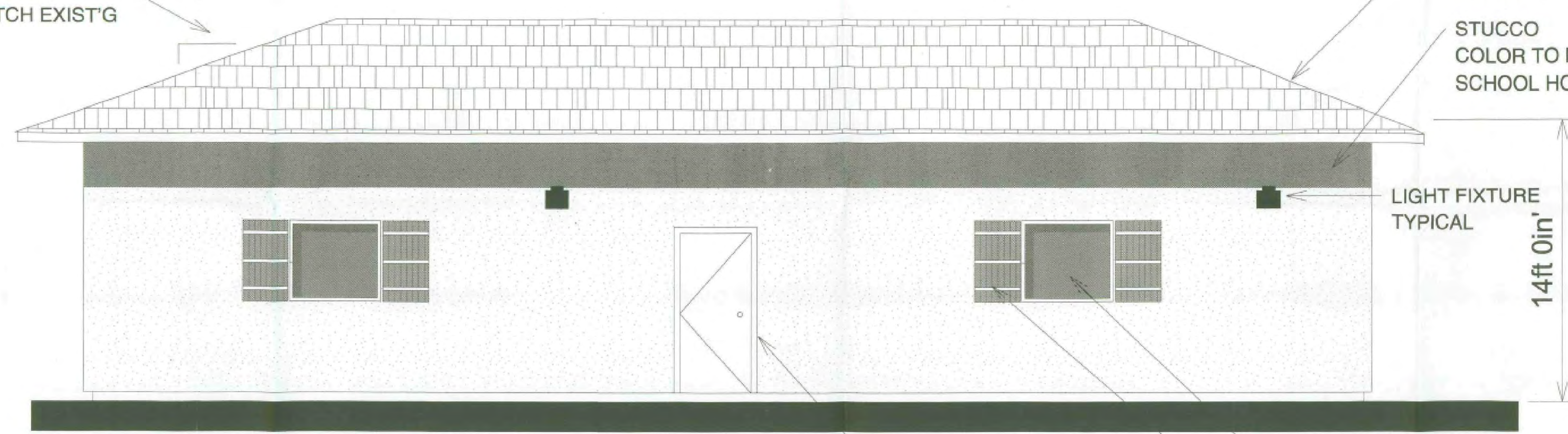
NO.	REVISION	PREPARED BY	DATE

MONTECITO RANCH WASTEWATER RECLAMATION FACILITY
SAN DIEGO COUNTY, CALIFORNIA
MONTECITO RANCH, LLC

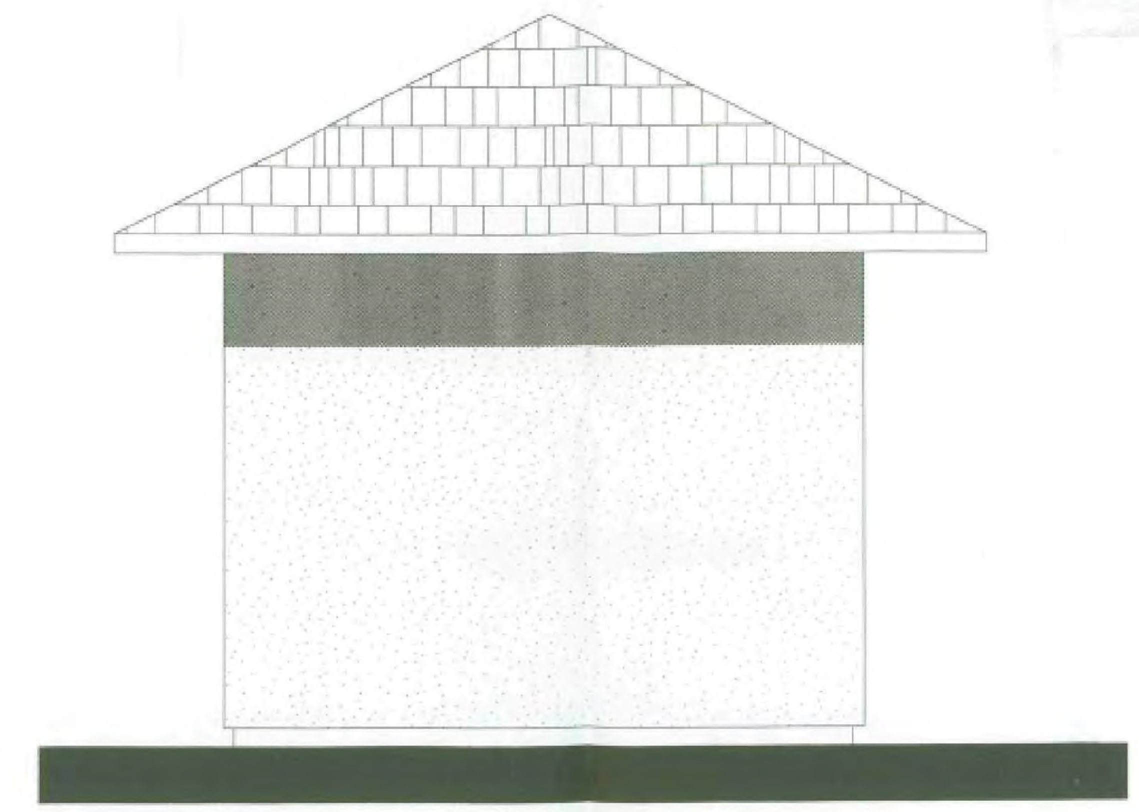
MAJOR USE PERMIT PLOT PLAN
P09-023

1

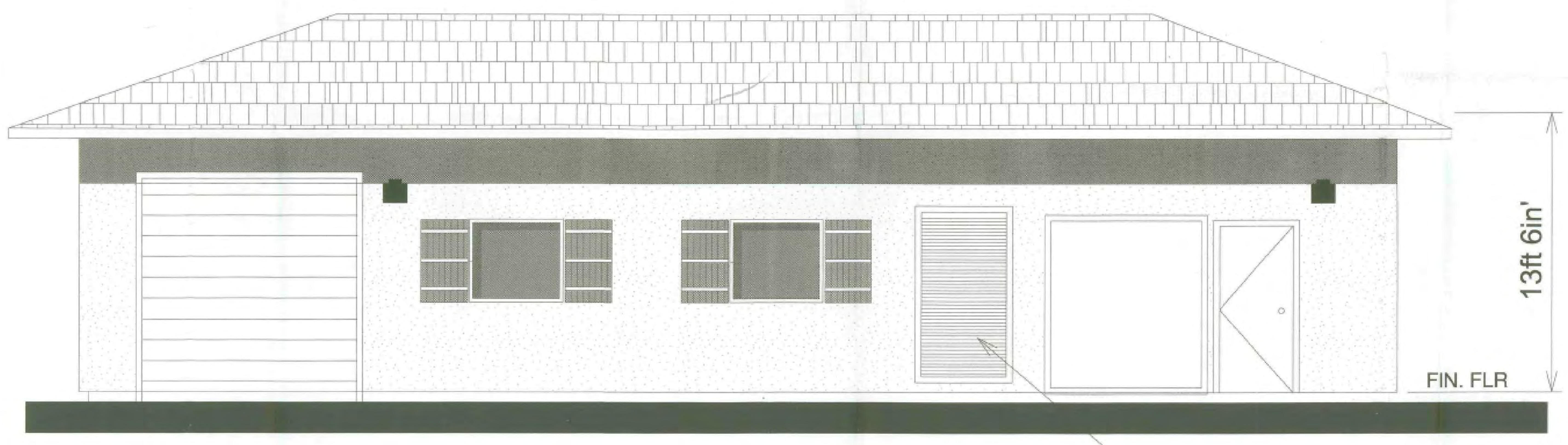
GPA 04-013, SPA 01-001, TM 5250 RPL6 MUP 09-023
MONTECITO RANCH
Log No. 01-09-013



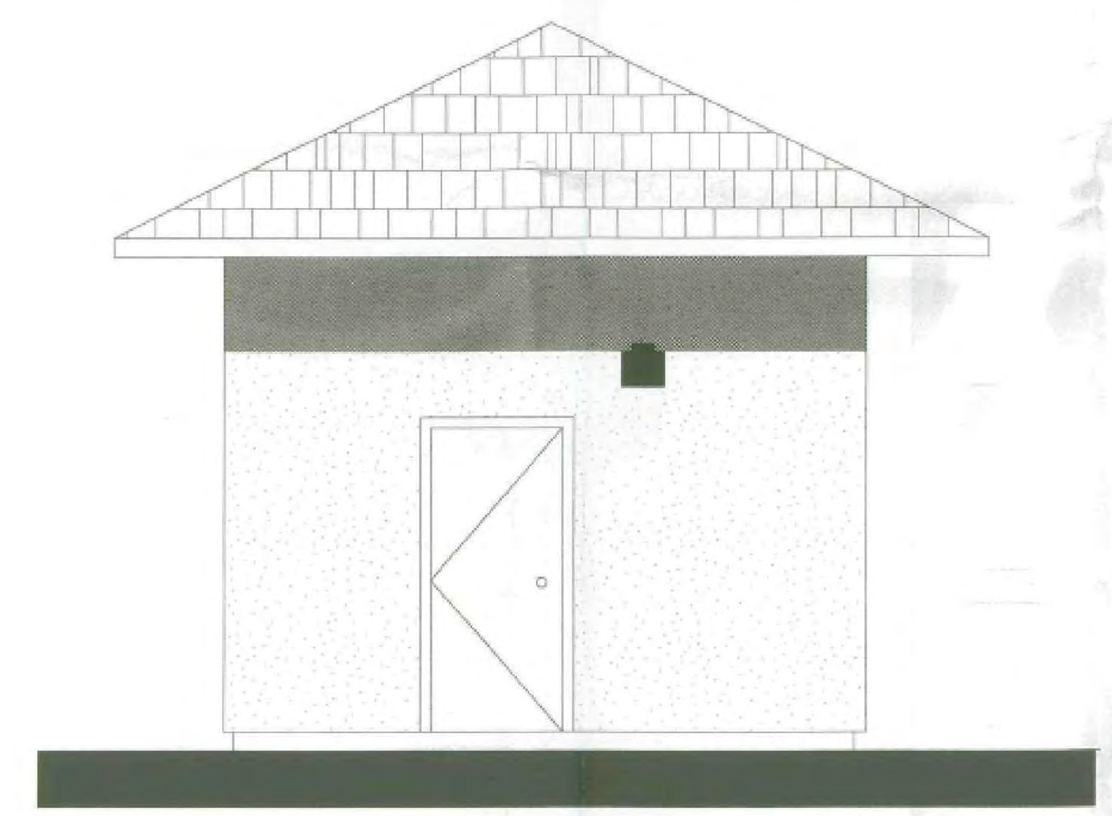
ELEVATION 1
1/4"=1'-0"



ELEVATION 2
1/4"=1'-0"



ELEVATION 3
1/4"=1'-0"



ELEVATION 4
1/4"=1'-0"

COUNTY OF SAN DIEGO
MAJOR USE PERMIT PLOT PLAN (P09-023)
MONTECITO RANCH WASTEWATER RECLAMATION FACILITY

Del Mar
619.793.5450

Development Design Services & GraphicAccess, Inc.

REGISTERED LANDSCAPE ARCHITECT
ADAM R. GEVANTHOR
No. 3393
Exp. 4/30/08
STATE OF CALIFORNIA

0 30 60 120 180
SCALE: 1" = 60'

February 13, 2007

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1	COUNTY COMMENTS		1-6-10

NO.	REVISION	PREPARED BY	DATE

MONTECITO RANCH WASTEWATER RECLAMATION FACILITY
SAN DIEGO COUNTY, CALIFORNIA
MONTECITO RANCH, LLC

MAJOR USE PERMIT LANDSCAPE CONCEPT PLAN
P09-023

L1

COUNTY OF SAN DIEGO
MAJOR USE PERMIT PLOT PLAN (P09-023)
MONTECITO RANCH WASTEWATER RECLAMATION FACILITY

PLANT LEGEND

MONTECITO RANCH ROAD STREETSCAPE

STREET TREE

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
QUERCUS AGRIFOLIA	COAST LIVE OAK	24" BOX	PLANT 2'-6" FROM EDGE OF SIDE WALK AT 25' O.C.
TRISTANIA CONFERTA	BRISBANE BOX	24" BOX	PLANT 2'-6" FROM EDGE OF SIDE WALK AT 25' O.C.

SHRUBS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
RHAPHIOLEPIS INDICA 'BALLERINA'	INDIAN HAWTHORN	5 GALLON	MAINTAIN AT 30" HIGH HEDGE PLANT 36" O.C.

INTERIOR AND ENTRY PLANTING

TREES

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
KOELREUTERIA BIPINATA	CHINESE FLAME TREE	24" BOX	
CUPANIOPSIS ANACARDIOIDES	CARROT WOOD TREE	24" BOX	
LAGERSTROEMIA INDICA 'NATCHEZ'	CRAPE MYRTLE	24" BOX	

LARGE SHRUBS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
PITTOSPORUM TOBIRA 'VARIEGATA'	VARIEGATED PITTOSPORUM	5 GALLON	
FEIJOA SELLOWANA	PINEAPPLE GUAVA	5 GALLON	
ARBUTUS UNEDO 'COMPACTA'	DWARF STRAWBERRY TREE	5 GALLON	
HETEROMELES ARBUTIFOLIA	TOYON	5 GALLON	

MEDIUM SHRUBS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
RHAPHIOLEPIS INDICA 'CLARA'	INDIAN HAWTHORN	5 GALLON	
LIGUSTRUM JAPONICUM 'TEXANUM'	TEXAS PRIVET	5 GALLON	

SMALL SHRUBS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
RHAPHIOLEPIS INDICA 'BALLERINA'	INDIAN HAWTHORN	1 GALLON	
NERIUM OLEANDER 'PETITE PINK'	DWARF OLEANDER	1 GALLON	

ACCENT SHRUB

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
PHORMIUM SPP.	NEW ZEALAND FLAX	5 GALLON	

PERENNIALS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
AGAPANTHUS 'QUEEN ANNE'	LILY-OF-THE-NILE	1 GALLON	
HEMEROCALLIS HYBRIDS	DAY LILY	1 GALLON	

GROUNDCOVERS

1

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
BACCHARIS PILULARIS 'TWIN PEAKS'	DWARF COYOTE BUSH	1 GALLON	PLANT AT 10' O.C.
ESCHSCHOLIZIA CALIFORNICA	CALIFORNIA POPPY	HYDROSEED	2 LBS. PER ACRE.
PLANTAGO INSULARIS	INDIAN WHEAT GRASS	1 GALLON	PLANT AT 3' O.C.
VERBENA TENUISECTA	MOSS VERBENA	1 GALLON	PLANT 3' O.C.

SLOPE PLANTING

TREES

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
POPULUS FREMONTII	WESTERN COTTONWOOD	5 GALLON	PLANT AT RATE OF: 1 PER 200 SQ. FT.
PLATANUS MEXICANA 'ALAMO'	MEXICAN SYCAMORE	5 GALLON	PLANT AT RATE OF: 1 PER 200 SQ. FT.

SHRUBS

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
CISTUS 'SUNSET'	ROCKROSE	5 GALLON	PLANT AT RATE OF: 1 PER 200 SQ. FT.
CEANOTHUS HORIZONTALIS 'YANKEE POINT'	WILD LILAC	5 GALLON	PLANT AT RATE OF: 1 PER 200 SQ. FT.

SHRUBS AND IRRIGATED HYDROSEED MIX

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
BACCHARIS PILULARIS 'TWIN PEAKS'	DWARF COYOTE BUSH	1 GALLON	PLANT AT 10' O.C.
ESCHSCHOLIZIA CALIFORNICA	CALIFORNIA POPPY	HYDROSEED	2 LBS. PER ACRE.
PLANTAGO INSULARIS	INDIAN WHEAT GRASS	HYDROSEED	60 LBS. PER ACRE.
VERBENA TENUISECTA	MOSS VERBENA	HYDROSEED	3 LBS. PER ACRE.

BOTTOM OF DETENTION BASIN PLANTING

NON-IRRIGATED HYDROSEED MIX

BOTANICAL NAME	COMMON NAME	SIZE	NOTES
MUHLENBERGIA RUGENS	DEER GRASS	HYDROSEED	2 LBS. PER ACRE.
LEYMUS TRITICOIDES	BEARDLEE WILDRYE	HYDROSEED	10 LBS. PER ACRE.
FESTUCA RUBRA 'MOLATE'	RED FOUNTAIN GRASS	HYDROSEED	8 LBS. PER ACRE.
DESCHAMPSIA ELONGATA	SLENDER HAIRGRASS	HYDROSEED	5 LBS. PER ACRE.
VULPIA MICROSTACHYS	SMALL FESCUE	HYDROSEED	5 LBS. PER ACRE.

NOTES:

1. Erosion control planting and irrigation shall comply with the County of San Diego requirements for erosion control.
2. Any grading associated with the maintenance road that will create slopes 3' in vertical height and above shall be permanently planted and temporarily irrigated to prevent erosion. Temporary irrigation to establish vegetation shall not influence the adjacent open space vegetation with irrigation run-off, overspray, or fertilizing.
3. If reclaimed water is not available for irrigation then planting areas shall be dual plumbed for potable and reclaimed water until which time reclaimed water is available for irrigation.
4. Reclaimed water shall be applied to spray fields with impact type irrigation heads designed as part of comprehensive distribution plan.

1

DESIGN STATEMENT / OBJECTIVES

1. Planting will be designed to obscure undesirable views (automobile, storage, utility areas, etc.) and add character and interest to the site. Where planting area exceeds eight feet in width, mounding shall be used. Planting shall blend with designs proposed for adjacent property.
2. Architectural elements of the site will be related and enhanced with plantings of similar design character.
3. All plant material selected for use will be of a type known to be successful in the area or in similar climatic and soil conditions.
4. Color from plant foliage, bark or flowers will be utilized to create a friendly, warm and visually exciting landscape environment. Thematic color schemes will be utilized in developing project identity. See final planting plans for installation layout, details and specifications.
5. All outdoor storage, loading, refuse and utility areas will be visually screened on all sides (except at access points). Planting will be used to soften hard materials where such are used for screening.
6. Vehicular entrances will be identified and accented with special groupings or trees, shrubs and/or ground covers, however, these areas shall not detract from the building as the focus of the site.
7. Slope plantings are intended to take place during the appropriate seasons of late fall or winter (November through February) for optimum results.
8. Landscape finish grading objectives will include positive surface drainage of planted areas throughout the site - a minimum of two percent (2%) away from building in planting areas. See civil engineering plans for final grading.
9. Irrigation systems will be permanent below ground automated systems adequate for the establishment and maintenance of all plant material. These systems will be installed as soon as practical after grading and prior to plant material installation. Areas adjacent to structures, roadways, entries and activity areas will be irrigated with permanent below grade automated systems.
10. Irrigation systems shall utilize low precipitation fixed and pop-up steam rotor, shrub spray and bubbler heads for transitional landscape areas, adjacent open space, parkways, parking area landscaping, building perimeter landscape planting and all lawn areas. Pop-up spray heads shall be used adjacent to walks, drives and activity areas.
11. All soils will be fertilized, amended, and tilled to conform to recommendations made by a soil testing laboratory and/or landscape architect in order to promote healthy and vigorous plant growth.
12. All planting areas will be privately maintained in a weed and debris free condition.

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L2